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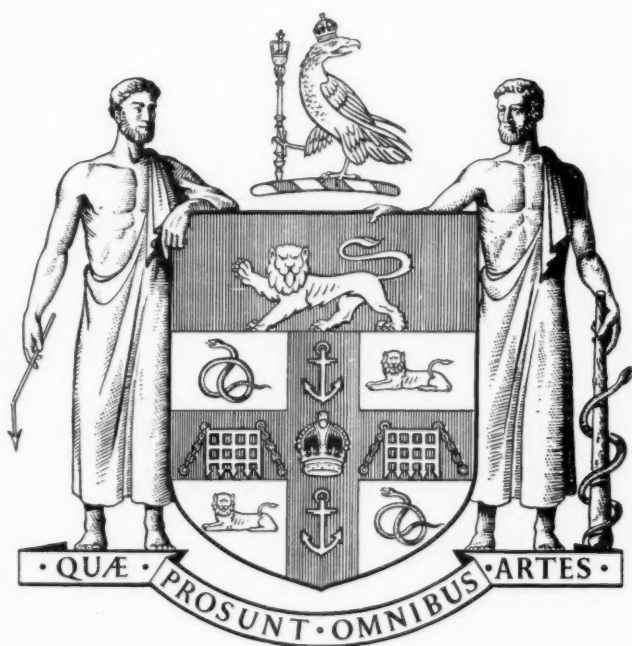## VOLUME 25

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THE EFFECT OF HORMONE DEPRIVATION UPON BREAST CANCER

Hunterian Lecture delivered at the Royal College of Surgeons of England

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by

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IN THIS LECTURE I propose to consider certain problems regarding human breast cancer. Seven specimens of this disease which formed part of John Hunter's museum have escaped destruction. They show that he had clear ideas of the diagnostic features of the growth in its many forms, of the natural history of the disease, and of its morbid anatomy.

He was particularly interested in the general biology of lactation and was well aware that a process akin to mammalian lactation is found in pigeons, doves and some parrots. There are two original Hunterian specimens of the pigeon crop in the museum ; one was taken between seasons (Fig. 1) and the other during the breeding season (Fig. 2), and both specimens are described in Hunter's *Animal Oeconomy*. To quote Owen's catalogue (1840) : " *Both parents contribute a nutritious secretion for the sustenance of the callow offspring.*" The milk, rich in casein, is projected into the oro-pharynx of the chicks.

It must have delighted John Hunter to learn of this phenomenon. It would give him great satisfaction to know that this variety of avian lactation is due to direct stimulation of the crop by the anterior pituitary hormone, prolactin, which plays so vital a part in inducing glandular differentiation and lactation in the mammalian mammary gland. The pigeon crop is remarkably and specifically sensitive to several varieties of mammalian prolactin, and this property is used in the standard bio-assay of this lactational hormone.

In about 50 per cent. of human breast cancers, progressive proliferation of the tumour cells depends, to a varying degree and for an uncertain time, on adequate and continuous stimulation by those hormones which are known to control normal mammary growth. This belief is largely founded on the work of three pioneer surgeons. The first, Sir George Beatson, induced objective growth regression in human breast cancer by bilateral oophorectomy in 1896 ; Charles Huggins obtained a similar response by bilateral adrenalectomy in 1951, and a year later Herbert Olivecrona reported the effects of hypophysectomy (Luft, *et al.*, 1952).

Endocrine ablation is now established in the treatment of selected cases of metastatic breast cancer, and I would like to recall to you a closely-related observation made by John Hunter in 1786—namely, that castration in male animals induces atrophy of the prostate. This observation has

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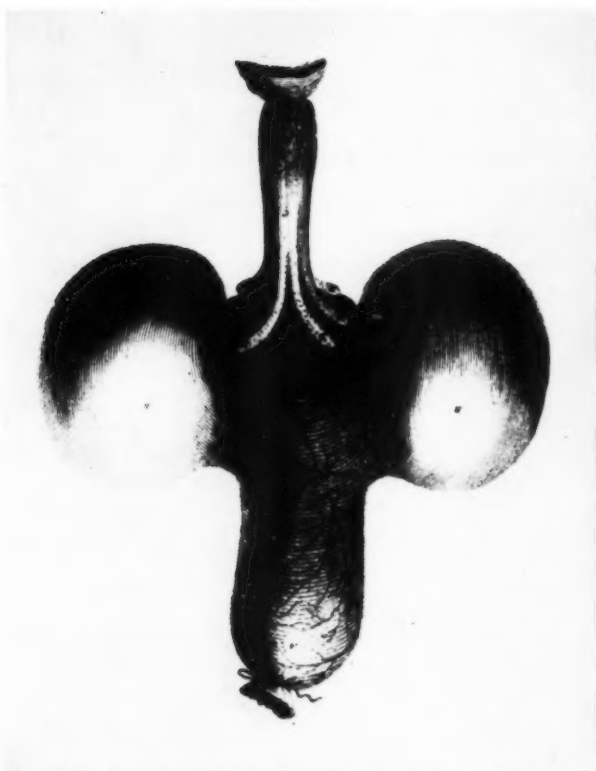
Fig. 1. The lower portion of the oesophagus of a pigeon during the non-breeding season showing the lateral sacculi or crop and part of the proventriculus. The walls of the crop are relatively thin and smooth. (Hunterian specimen No. 3739, described in Volume V of Owen's catalogue (1840). The specimen is figured by John Hunter in his *Animal Oeconomy*, see footnote).

certainly played its part in establishing castration as an important therapeutic measure in the modern treatment of prostatic cancer.

The briefest acquaintance with the highly complex endocrinological and biochemical background of hormone-dependent human breast cancer leads to the conviction that in the investigation of this condition the clinician must collaborate with the scientist. There are, however, many difficulties in the correlation of laboratory investigations with the clinical course of a human disease, and there are large gaps in our

Footnote : " . . . by the time young are about to be hatched, the whole, except what lies on the trachea, becomes thicker and takes on a glandular appearance having its internal surface very irregular. It is likewise evidently more vascular than in its former state." (*Animal Oeconomy*, 2nd edit., p. 235.)

knowledge of the nature of hormone dependence in cancer. For these reasons significant results are unlikely to emerge quickly.

THE NATURE OF HORMONE DEPENDENCE

The epithelial cells of the normal breast cease to divide if they are deprived of the group of ovarian or pituitary hormones which are normally responsible for mitosis in mammary epithelium. Mammary epithelium is, in fact, totally and invariably hormone-dependent. The cells of about 50 per cent. of all human breast cancers are also hormone-dependent because they have retained this deeply-imprinted characteristic of normal

Fig. 2. Specimen, corresponding to Figure 1, from a male pigeon of the same species during the breeding season. The walls of the crop are swollen and deeply corrugated by a complex network of folds. (Hunterian specimen No. 3740, described in Volume V of Owen's catalogue (1840) and figured in *Animal Oeconomy* —see footnote to Fig. 1).

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mammary epithelium. The arrest of growth in hormone-dependent metastatic breast cancer by oophorectomy, adrenalectomy or hypophysectomy, therefore, is nothing more than the exploitation of a characteristic inherited by malignant cells from the normal cells from which they originate.

It is beyond question, however, that 50 per cent. of all human breast cancers are primarily hormone-*independent* and invulnerable to hormone therapy, whilst an uncertain proportion of hormone-dependent tumours develop secondary independence during their clinical course. This latter sequence has been explained by postulating that a population of hormone-dependent breast cancer cells contains a small minority of hormone-independent cells. Endocrine ablation induces mitotic arrest of the dependent majority. After a variable period of time the *hormone-independent* cells proliferate and when they constitute the majority of the cell population, the tumour becomes independent. These considerations lead me to the dismal conclusion that a high proportion of breast cancers of more than a few years' duration are, or become, primarily or secondarily independent of hormones. This situation recalls the phenomenon of penicillin sensitivity and resistance in populations of staphylococci.

Hormone dependence, whilst uncommon in human cancers, is a striking characteristic of experimental cancers induced by the long-continued injection of hormones (Ciba Colloquium, No. 12). Mitotic arrest is rapidly induced in such tumours by withholding the hormones which induced them, but it is highly significant that *all the cells of such tumours do not perish;* a variable number survives and can be induced to grow by again administering the carcinogenic hormone, and this sequence can be repeatedly induced. These results suggest that when a growth regression is induced in human breast cancer by endocrine ablation there is a high probability that a proportion of its cells will survive, even for periods measured in years, and may again produce a clinically recognisable growth whenever the original hormonal background of the tumour is restored. It is tempting to suppose that this sequence is in operation when a human breast cancer goes into natural regression for a period of years, and then, for no obvious reason, enters a phase of growth acceleration.

Sir Gordon Gordon-Taylor (1959) believes that such growth acceleration is brought about by acute infection and sometimes by irradiation. It may be that any severe stress will induce a steep enough rise in the production of adrenal steroids to restore a hormonal background appropriate to the needs of the tumour cells.

It appears to be a biological fact, for which there is no obvious explanation, that 50 per cent. of all breast cancers are primarily hormone-dependent for an unpredictable time. Table I shows that a significant objective regression of tumour growth was induced by hypophysectomy in 48.6 per cent. of 400 unselected patients with metastatic breast cancer and in 59.5 per cent. of 185 selected patients.

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TABLE I

HYPOPHYSECTOMY SERIES

Author	Number of cases		Percentage Improved
	Total	Selected	
LUFT, *et al.* (1956)	52	42	42.3 53.6
ibid—review of the literature ..	197		56.0
RAY and PEARSON (1956)	74	67	48.6 53.3
KENNEDY, *et al.* (1956)		28	64.0
BARON, *et al.* (1958)	52	33	42.3 66.6
MATSON (1958) quoted by Jessiman ..	25		54.0
SCOWEN (1958)		15	60.0

Out of 400 unselected breast cancer patients, 48.6 per cent. improved after hypophysectomy.

Of 185 selected patients, 59.5 per cent. improved after operation.

A similar mean rate of growth regression is found in any large series of adrenalectomised patients (see Table II).

TABLE II

ADRENALECTOMY SERIES

Author	Number of cases		Percentage Improved
	Total	Selected	
HUGGINS (1955)	100	95	38.0 40.0
TAYLOR (1956)	60		36.0
LIPSETT, *et al.* (1957)	70	67	51.4 55.7
CADE (1958)..	137		58.0
HELLSTROM and FRANKSSON (1958) ..	150		51.0
PYRAH (1958)	75		52.0

Out of 592 unselected breast cancer patients, 47.7 per cent. improved after adrenalectomy.

Of 162 selected patients, 47.8 per cent. improved after operation.

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HORMONAL FACTORS IN NORMAL MAMMARY GROWTH

For precise information on this fundamental problem we must turn to the experimental animal, apply the results to the human mammary gland with due caution, and confirm them whenever possible with parallel clinical studies of growth in the normal and abnormal human breast.

Extensive studies of normal mammogenesis in the rat have been published by W. R. Lyons of the University of California, and he presented a summary, embracing the results of twenty-five years' research on this problem, in a recent address to the Royal Society (1958). In the Surgical Professorial Unit of St. Bartholomew's Hospital, by using the intact and hypophysectomised rat and mouse, we have been able to confirm some of Lyons' findings (Donath, *et al.*, 1958) and similar conclusions have been reported from the Clinico-pathological Laboratories of the Imperial Cancer Research Fund (Hadfield and Young, 1958). These studies strongly suggest that pituitary growth hormone may be deeply implicated as a supporting hormone in human breast cancer.

Normal mammogenesis proceeds in three distinct phases:

1. A mitotic phase of epithelial proliferation culminating in the production of a duct system.

2. A phase of glandular differentiation leading to the formation of a functionally-competent gland.

3. The establishment and maintenance of lactation. Each phase requires a different synergistic combination of pituitary, ovarian and adrenal cortical hormones.

Omitting the lactation phase, the hormonal combinations required for the production of a functionally adequate, competent gland are shown in Table III.

TABLE III

HORMONES INVOLVED IN BRINGING THE MAMMARY GLAND OF THE RAT TO FULL FUNCTIONAL STATUS (LYONS, 1958)

	Pituitary	Hormones contributed by Ovary	Adrenal
Growth of duct system	Growth hormone	Oestrogen*	Cortico-steroids*
Full glandular differentiation	Growth hormone Prolactin	Oestrogen Progesterone*	Cortico-steroids

* Ovarian oestrogen production controlled by pituitary gonadotrophin.
* Ovarian progesterone production controlled by pituitary prolactin.
* Adrenal corticoid production controlled by A.C.T.H.

Hadfield and Young, using the rudimentary mammae of the male weanling mouse, totally hypophysectomised at the age of twenty-three days, obtained the results given in Table IV.

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TABLE IV

MAMMARY GROWTH RESPONSES ELICITED IN TOTALLY HYPOPHYSECTOMISED MALE WEANLING MICE BY THE ADMINISTRATION OF VARIOUS HORMONE COMBINATIONS (DATA OF HADFIELD AND YOUNG, 1958)

Hormones given	Result
Oestrone alone .. .. Progesterone alone .. .. .. Oestrone + Progesterone .. .. Growth hormone alone .. .. .. Prolactin alone .. .. Growth hormone + Prolactin	The mammary atrophy inevitably following total hypophysectomy continues unchecked.
Growth hormone + Oestrone + Progesterone	Prolific mammary growth response with striking mitotic activity and rapid epithelial proliferation.

These results show that the oestrogenic and progestational steroid hormones cannot induce a mammary growth response in the absence of the pituitary, and pituitary hormones acting alone cannot do so.

SOME NON-NEOPLASTIC DISEASES OF THE HUMAN BREAST

Studies of disease in man reveal a series of patients in whom breast growth is influenced by hormonal changes.

The pituitary destruction of Simmonds' disease deprives the mammary gland of growth hormone, prolactin, gonadotrophin and A.C.T.H. Lack of the last three hormones arrests the production of ovarian oestrogen and progesterone and adrenal steroid hormones. The hormonal status of the patient is identical with that of the totally hypophysectomised rat, and the mammary gland shows an extreme degree of glandular atrophy.

Anorexia nervosa has a general clinical resemblance to Simmonds' disease but the loss of bulk of the mammary glands is not due to atrophy of the glandular tissue, being solely accounted for by loss of fat, and the two diseases have little in common apart from extreme wasting.

At the present time Dr. Scowen and I are studying, at St. Bartholomew's Hospital, a series of male patients who have gynaecomastia. In some of these there was clear evidence of the production of an extensive mammary duct system with some glandular differentiation ; this was associated with selective atrophy of the seminiferous tubules of the testis and little or no detectable change in urinary oestrogen levels. We have investigated this problem in mice. Irradiation of the testes of weanling males at a dose which caused atrophy of the seminiferous tubules but no change in the interstitial cells, induces an unmistakable growth response in mammary glands.

Studies of female patients having granulosa-cell tumours of the ovary and excess production of oestrogens help us to appreciate the role of oestrogen in the rapid growth of the breast at puberty. Meyer (1938) reported on a series of thirty-three patients with granulosa-cell tumours ; two of the three children included in the series, aged five and eleven years,

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had hypertrophy of the breast and one of them secreted colostrum. Four of the adult patients had hypertrophy of the breast and two of these, aged sixty-one and seventy years, had galactorrhoea. It appears, therefore, that in childhood the oestrogen and progesterone secreted by the tumour, together with the growth hormone produced at the high level of childhood, was responsible for precocious mammary growth. In the older patients it must be assumed that pituitary function was active and that breast activity was the result of the synergistic action of pituitary prolactin with the steroid hormones produced by the tumour.

NATURAL HORMONE DEPRIVATION

One physiological event frequently retards the progress of hormone-dependent metastatic breast cancer. This is the physiological castration of the normal menopause. The cessation of menstruation is rapidly followed by a considerable fall in the production of ovarian oestrogens and a proportionate rise in the production of pituitary gonadotrophin. Whilst this rise and fall in hormone production shows quantitative differences from one individual to another, its general pattern remains remarkably constant under physiological conditions (Struthers, 1956).

The period of oestrogen deprivation which follows the onset of the menopause varies from one to five years, and available evidence strongly suggests that during this time progressive growth in hormone-dependent metastatic breast cancers which have arisen *before the onset of the menopause* is often retarded and may be temporarily arrested. Furthermore, statistical evidence suggests that the incidence of clinically detectable breast cancer arising during this period of natural oestrogen deprivation shows a substantial fall.

It would clearly be unjustifiable to assume that the menopausal fall in oestrogen production *prevents the development of a hormone-dependent*
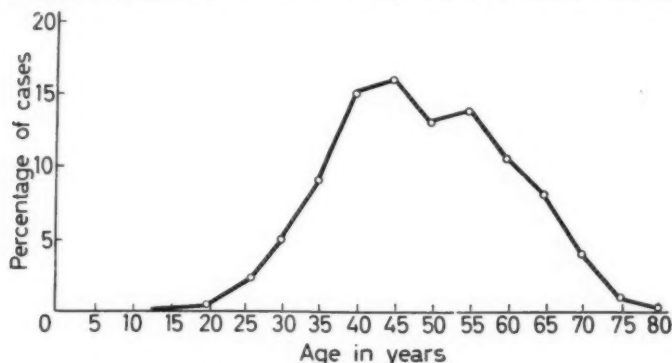
Fig. 3. Graph showing the bimodal distribution of 13,054 cases of Breast Cancer according to age at onset. Data kindly supplied by Dr. N. E. Treves—patients seen at Memorial Hospital, New York.

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breast cancer during this time. The available evidence, however, does suggest that the growth rate is retarded to such an extent that clinical recognition of the tumour is delayed. This evidence has been provided by plotting the incidence of breast cancer in large numbers of patients against age intervals of five years (Fig. 3). Such curves show a bimodal distribution reaching the first peak at about forty-five years followed by a striking and abrupt fall in incidence from forty-five to fifty years, rising to a second peak at fifty-five to fifty-seven years. The second peak of the bimodal curve corresponds, in all probability, to the establishment of oestrogen production by the adrenal cortex, which rectifies the oestrogen lack due to physiological castration.

In women who develop a hormone-dependent breast cancer a few years before the menopause, and have already developed metastases when they enter the menopause, there is a strong tendency for the growth to undergo spontaneous regression. This may persist through the period of oestrogen deprivation but is invariably followed by a period of growth progression. Spontaneous menopausal regression can, of course, only occur in the 50 per cent. of cases of breast cancer which are oestrogen-sensitive.
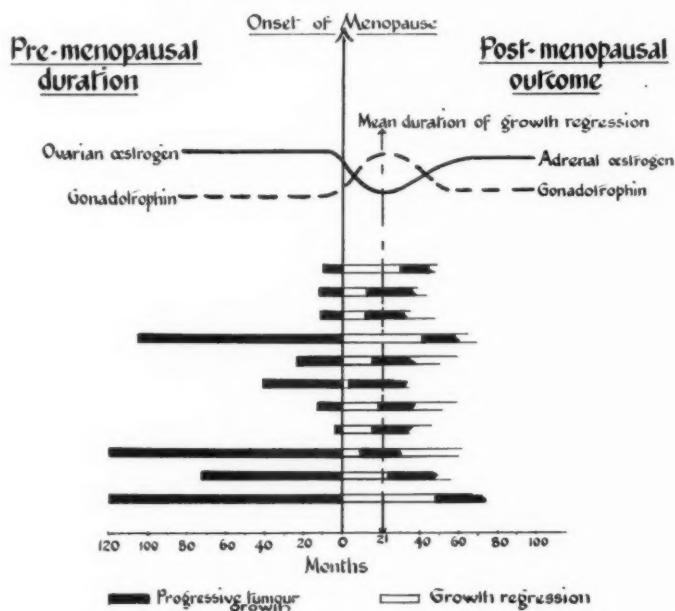
Fig. 4. Diagram constructed from figures in Table V showing duration of growth regression in relation to the average post-menopausal fall of oestrogen excretion and of growth acceleration in relation to the adrenal " take-over."

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During the time case histories of eleven such patients were being closely investigated (Hadfield and Holt, 1956), other patients were encountered in whom no objective growth regression occurred during the menopause. The period of menopausal growth regression in our series varied from three to forty-eight months and had a mean duration of twenty-one months (Table V : Fig. 4).

TABLE V

ELEVEN CASES OF METASTASISING PRE-MENOPAUSAL BREAST CANCER SHOWING A NATURAL GROWTH REGRESSION STARTING DURING THE MENOPAUSE (HADFIELD AND HOLT, 1956)

Pre-menopausal duration of the disease (months)	Menopausal and post-menopausal growth regression (duration in months)
10	30
12+	13
11	12
108	42
24	15
42	3
12	19
3	15
120	9
72	24
120	48
	(Mean duration = 21 months)

A parallel series of pre-menopausal patients who underwent surgical castration in an effort to control the growth of their metastatic breast cancer (Fig. 5) was compared with our patients having a natural regression

HADFIELD B.R.I SERIES
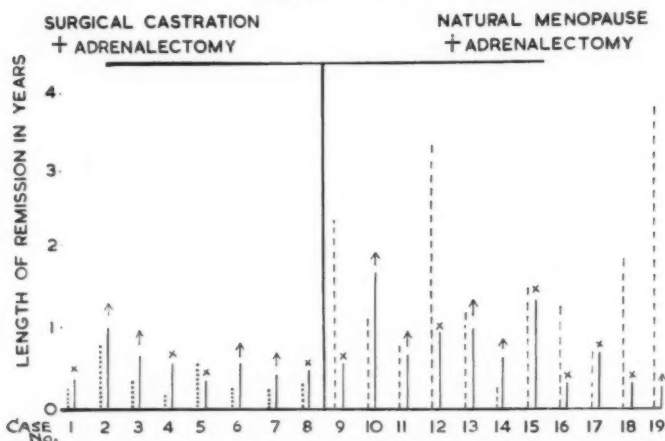
Fig. 5.   Diagram showing the duration of growth regressions induced by surgical castration and adrenalectomy compared with the duration of spontaneous regressions which may accompany the menopause.

during the menopause. The length of regression following surgical castration, a mean duration of six months, was significantly shorter than that noted in the menopausal group—twenty-one months. The difference may be explained by the fact that during the natural menopause simultaneous changes occur in pituitary function ; surgical castration removes only the ovarian component of the oestrogen-producing mechanism (Bulbrook *et al.*, 1958*a*). Patients in whom metastases have spontaneously and temporarily regressed with the menopause, and have again resumed progressive growth as oestrogen production by the adrenal becomes established, derive considerable but temporary clinical benefit from adrenalectomy (Fig. 5).

THE INCIDENCE OF METASTASES AT VARIOUS SITES

It is always a distressing experience to discover that a patient with Stage I breast cancer has a blood-borne metastasis in a distant organ. Until fairly recently there was little information on the frequency of this tragic accident but we are likely to have precise information on this problem in the near future from examination of the peripheral blood for circulating cancer cells (Sandberg and Moore, 1957 ; Roberts *et al.*, 1958). The common sites of blood-borne metastases are shown in Table VI.

TABLE VI

SITE OF BLOOD-BORNE METASTASES—COMPILED FROM WILLIS (1952) AND OTHER SOURCES

Site	Percentage occurrence
Lung and Pleura	66
*Skeletal	50
Liver and peritoneum	50
Endocrine organs	30
Central nervous system	20

* Skeletal metastases are found in the spine, pelvis, femur, ribs and skull in this order of frequency.

Most observers agree that hepatic and cerebral metastases are refractory to endocrine ablation.

METASTASES IN ENDOCRINE ORGANS

Metastases in the endocrine organs are of some clinical significance. Table VII gives a summary of the incidence in series reported by various authors.

One of the common sites of metastases in breast cancer is the haemopoietic bone marrow. This is not surprising for this tissue is highly vascular and the rate of blood flow through its sinusoidal capillaries is slow.

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tumour growth. It may prove to be more common than the meagre evidence suggests. Destruction of the pituitary causing auto-hypophysectomy may arise in one of two ways :

. 1. By destruction of the whole gland by the coalescence of multiple metastatic foci, with or without simultaneous thrombosis of the blood supply ; or

2. By invasion and destruction of the gland from spreading metastases in the basal meninges around the sella turcica or, rarely, from the sphenoid bone.

The first sequence is well illustrated by histological studies made on the fragments of pituitary removed at surgical hypophysectomy. The major part of the anterior pituitary has been destroyed by metastatic growth (Figs. 6 and 7).
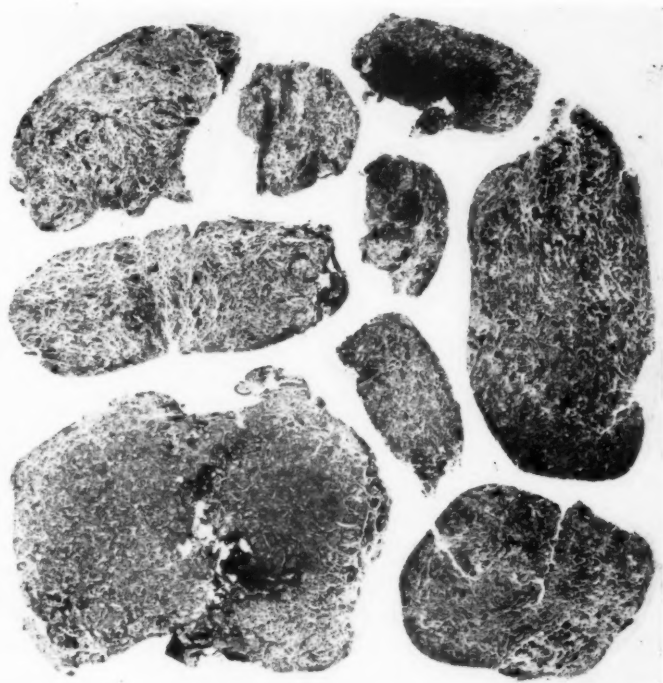
Fig. 6. Sections of fragments of pituitary gland removed at surgical hypophysectomy for metastatic breast cancer. ×50 on original plate.

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Fig. 7. Diagram showing the extent of destruction of anterior lobe by tumour tissue. Areas totally replaced by carcinoma (Fig. 6) are black ; pars nervosa—indicated by cross hatching ; surviving anterior lobe tissue is unshaded. (Magnification as in Fig. 6).

In a series of twenty-six patients at St. Bartholomew's Hospital, we have studied three in whom there appears to have been a spontaneous hypophysectomy and temporary regression of the disease, due to destruction of the pituitary by metastatic growth. In the remaining twenty-three patients, four were shown to have microscopic foci of metastatic growth in the pituitary and two others had pituitary invasion by growth originating in the basal meninges around the pituitary fossa or in the sphenoidal bone.

THE EFFECTS OF SURGICAL ABLATION OF ENDOCRINE SOURCES IN PATIENTS WITH METASTATIC BREAST CANCER

In this section I can do no more than summarise our present views on the value of the removal of endocrine glands in the control of metastatic breast cancer. Extensive investigations have been undertaken, in colla-

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boration with the workers in the Biochemistry Unit of the Imperial Cancer Research Fund, and we have published our attempt to correlate clinical results with the urinary oestrogen levels (Bulbrook, *et al.*, 1958*a*, *b* and *c*).

Oophorectomy

The oophorectomy series studied (Bulbrook, *et al.*, 1958*a*) has to be divided into pre-menopausal and post-menopausal women. In the pre-menopausal group oestrogen excretion did not fall to, or remain at, zero after the operation. In all the patients studied there was a material fall in oestrogen excretion post-operatively. This was maintained for a varying period of time and then rose gradually, presumably as a result of oestrogen secretion by the adrenals or from other sources. Objective remission did not invariably follow the fall in oestrogen excretion although all patients obtaining a regression did in fact show a fall in oestrogen levels. A rise in oestrogen excretion accompanies progression of the disease in these patients but a further fall can be induced with adrenalectomy or hypophysectomy. An analysis of these patients gives an objective regression rate of about 25 per cent., the effect lasting on the average for six months, and this agrees with the results of the pre-menopausal series reported by Thomson in 1902, and by Lett in 1905.

Examination of published data shows a sharp contrast between the findings in post-menopausal women and the pre-menopausal series. Objective growth regression is very uncommon in post-menopausal women after castration. In Lett's series (1905) growth regression was limited to a single patient out of a total of twenty-five. Our series included six post-menopausal women who had been treated by oophorectomy. The clinical course of the disease and the oestrogen levels remained unchanged in all of them, although the immediate post-operative stress of oophorectomy caused a temporary increase in oestrogen excretion.

Occasionally a regression following oophorectomy has been reported in a menopausal or post-menopausal woman, and it has been suggested that this can be explained on the grounds of an unusual menopausal pattern in which the oestrogen level, although largely provided by the adrenal, might have a significant ovarian component.

Adrenalectomy

This series of patients showed marked reduction in the amount of oestrogen excreted after bilateral adrenalectomy with, or following, oophorectomy. When a material fall in oestrogen level followed operation, sometimes to undetectable amounts in the immediate post-operative period, it might be concluded that, in fact, operation had removed the body oestrogen. Follow-up of these patients, using estimations over several days each month, showed that there was spasmodic excretion of small amounts of oestrogen. This is a direct distinction from the post-oophorectomy effect where urinary oestrogen excretion remains continuous at a low level.

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In our post-adrenalectomy patients the clinical course of the disease did not faithfully follow variations in oestrogen levels (Bulbrook *et al.*, 1958*b*). Some, but not all, of the patients had a measurable regression of disease with a fall in oestrogen excretion after operation, but this was not invariable. A rise in oestrogen level in patients in whom there had been a fall in body oestrogen and regression of disease after operation was usually accompanied by further progression of the disease. The source of this oestrogen is still not known but in our study of completed cases, *post-mortem* examination from the diaphragm to the pelvic floor has consistently failed to reveal macroscopically-recognisable adrenal rests or hypertrophy of adrenal or ovarian remnants. Investigations into the possible source of this oestrogen are continuing; the retroperitoneal mesenchyme of the posterior abdominal wall, and the tumour and its metastases, have been suggested as possible sources.

Two groups of patients in this series are of interest on account of their unusual behaviour. In the first, two patients had a low pre-operative oestrogen excretion which remained unchanged after operation. In spite of this, clinically recognisable regression followed for a period of about six months. It has been suggested that this paradox, difficult to explain on the grounds of simple oestrogen removal conditioning regression of disease, may be due to the removal of another hormone, progestational in nature. The second group consisted of two other patients whose disease was not influenced by adrenalectomy in spite of a very great fall in oestrogen excretion to levels undetectable by clinical means or bio-assay. Measured regression was, however, obtained for periods up to five months after surgical hypophysectomy. This suggests the combined action of the physiological " mammotrophic triad " on the growth of breast cancer.

Hypophysectomy

All these patients were treated by surgical hypophysectomy by Mr. J. E. A. O'Connell of St. Bartholomew's Hospital, and the findings in most of the cases have been fully reported (Bulbrook, *et al.*, 1958*c*). General conclusions have been drawn as follows. The patients who obtained regression after operation tended to have a low pre-operative oestrogen level. In the majority, urinary oestrogen excretion was not detected by our methods after operation. There were, however, exceptions —for example, patients showing objective regression of disease in spite of a continued excretion of oestrogen post-operatively. These originally had a higher pre-operative level than the first group described, and the percentage of regressions following operation was lower than in the patients with a low pre-operative oestrogen excretion. This observation is hard to interpret. It shows, however, that a fall in oestrogen excretion to an undetectable level after operation is not obligatory for regression of the disease.

Three of our patients with progressive disease in the absence of demonstrable oestrogen excretion before operation, were put into

temporary regression for periods varying from three months, five months and two years, respectively, after hypophysectomy.

The first two had previously undergone adrenalectomy with subsequent regression of the disease and then relapsed. The last patient, an old post-menopausal woman, had had no previous surgical removal of endocrine glands. These patients apparently gained relief without any change in oestrogen excretion consequent upon operation. One may therefore ascribe the improvement to the removal of the mammotrophic principle of the pituitary alone, or together with the removal of trophic hormones from the adrenals and ovaries.

It must not be forgotten, however, that the method of oestrogen estimation (Brown, 1955) measures about 60 per cent. of the total body oestrogen, and changes in oestrogen levels may have occurred which were not detected by this method. It may be that we are unduly impressed by the oestrogenic hormones because ovariectomy and adrenalectomy should theoretically be able to suppress their formation. Yet in the large majority of instances these operations are almost always followed by a recrudescence of oestrogen production.

In the first place, there is little doubt that the state of oestrogen lack induced by castration and adrenalectomy provides the appropriate physiological stimulus which releases gonadotrophin and prolactin from the anterior pituitary, and as long as oestrogen lack continues, gonado-trophin will be produced at a high level and most, if not the whole, of this excess production will be excreted, as it has no available target organ. Eventually some organ or tissue must be *modified to become a specific emergency target organ for gonadotrophin*, and as its efficiency increases, increasing quantities of oestrogen will be produced under gonadotrophic stimulation.

What is the tissue of origin of this oestrogen in castrated-adrenalecto-mised women ? Are there any tissues in the body which, under an appropriate stimulus, are capable of taking over oestrogen production in the absence of the ovary and adrenal ?

In looking for such an emergency target organ we search for a neatly-encapsulated adrenal rest. It may be that retroperitoneal mesenchyme takes over oestrogen production, and does so in a diffuse manner, in much the same way as the yellow fat of the tibia becomes totally trans-formed into red haemopoietic bone marrow under the stress of oxygen lack.

Apart from the fact that the retroperitoneal mesenchyme is the birth-place of the ovaries and adrenal cortex, a confusing variety of primary malignant tumours arise from its remarkably fertile cells, and I would quote from the *Lancet* a Leading Article on 19th October, 1957 :

" Many a clinical reputation lies behind the peritoneum. In this hinterland of straggling mesenchyme, with its vascular and nervous plexuses, its weird embryonic rests, its shadowy fascial boundaries, the clinician is often left with only his flair and his diagnostic first principles to guide him."

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One thing is certain : epithelial proliferation in the normal breast and in hormone-dependent breast cancers needs a group of never less than three pituitary ovarian and adrenal hormones acting in synergism and n optimal proportions. There is good experimental evidence that cellular proliferation by mitosis is controlled by pituitary growth hormone. Glandular differentiation calls for another group ; the initiation of lactation for yet another, and the maintenance of lactation for a fourth.

The operation of these " multiple synergisms "—to borrow a term used by Lyons—lies at the root of the growth, development and function of the normal breast. To transform a rudimentary mammary gland to a lactating gland needs at least five pituitary hormones, ovarian oestrogen and progesterone and certain adrenal cortico-steroids. A synergistic triad of hormones whose members are inseparable is probably responsible for cellular proliferation in hormone-dependent breast cancer.

May I, in conclusion, remind you of the views of Celsus on cancer in general ? You may feel that they apply to the problems of breast cancer :

" There is not so great danger of a breast cancer unless it be irritated by the imprudence of a physician."

Finally, I would like to express my indebtedness to Professor Sir James Paterson Ross, Director of the Surgical Unit, and to Dr. E. F. Scowen, Director of the Medical Unit, at St. Bartholomew's Hospital, for advice and guidance, and for clinical and laboratory facilities. The Surgical Staff of the Hospital have kindly allowed me to study their patients with breast cancer, and all the hypophysectomies were performed by Mr. J. E. A. O'Connell.

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THE PRINTING STRIKE

WE REGRET THE late appearance of the July issue of the ANNALS but this is due to circumstances outside our control. We are endeavouring to make up for this delay by combining the August and September issues in one. We hope that this will prove satisfactory to our readers.

LOBECTOMY AND BRONCHIAL ANASTOMOSIS IN THE SURGERY OF BRONCHIAL CARCINOMA

Hunterian Lecture delivered at the Royal College of Surgeons of England

on

27th November, 1958

by

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SINCE GRAHAM'S SUCCESSFUL pneumonectomy for carcinoma of the lung in 1933, the operation was widely performed until recent years as the procedure of choice. The results of the order of 20-35 per cent. five years' survival reported by Churchill, Price Thomas, Brock and Sellors, compared well with the results of surgical treatment of carcinoma in other sites.

During the ensuing twenty-five years a number of patients have been studied at varying periods of time following the complete removal of one lung. It is clear that in younger patients the operation is well tolerated—in elderly people or in patients with diminished cardio-respiratory reserve, the position is less satisfactory. This point cannot be better illustrated than by reference to the work of Adams from the University of Chicago. The first table shows the mortality rate of pneumonectomy according to the age of the patient, and as it is seen that the operative mortality in the over sixty group is more than 25 per cent., this cannot be regarded with complacency.

TABLE I

MORTALITY RATES BY AGE GROUPS IN SURGERY FOR LUNG CARCINOMA. (ADAMS)

Age	Pneumonectomy	Dead
60+	70	18 25·7%
50—59	76	12 15·7%
49—	50	1 2%

An analysis of Price Thomas's personal series illustrates the same experience.

TABLE II

MORTALITY FOLLOWING PNEUMONECTOMY ACCORDING TO AGE. (PRICE THOMAS)

Age	Number of operations	Dead	Percentage
60+	105	23	22%
50—59	163	33	20%
49—	83	6	7%

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A comparison between the mortality for pneumonectomy and lobectomy in corresponding age groups shows a considerable reduction in older patients for the latter operation :

TABLE III

MORTALITY RATES BY AGE GROUPS IN SURGERY FOR LUNG CARCINOMA. (ADAMS)

Age	Pneumonectomy	Dead	Lobectomy	Dead
60+	70	18 25·7%	30	3 10%
50–59	76	12 15·7%	24	3 12·5%
49–	50	1 2%	37	1 3%

Apart from this initial operative mortality, Adams showed that thirty-three surviving patients after lung resection had significant elevation in pulmonary artery pressures, particularly after exertion. This increased vascular resistance is closely correlated with the functional incapacity of the patient following his operation ; it is most marked in the. sixth and seventh decades of life.

TABLE IV

MORBIDITY FOLLOWING PNEUMONECTOMY ACCORDING TO AGE. AFTER ADAMS' INVESTIGATION OF 33 POST PNEUMONECTOMY PATIENTS

Degree of pulmonary functional incapacity	49–	50—59	60+
None (11 patients)	8	3	0
Slight-moderate (12 patients)	6	2	4
Moderate-severe (7 patients)	4	2	1
Severe-complete (3 patients)	0	0	3

For these reasons the more limited operation of lobectomy has been widely practised in recent years. In 1956 Belcher, and in 1958 Cleland have been able to report a large combined series of lobectomy cases carried out since 1950, and show the survival rate of up to five years.

Lobectomy, where possible, is indicated in patients with low pulmonary reserve ; as a palliative measure, where the growth has extended beyond surgical bounds and when doubt exists in the diagnosis. There is general agreement with the performance of lobectomy for bronchial carcinoma where the tumour is small, circumscribed and unassociated with gross regional lymph node enlargement.

Unfortunately, in many cases the tumour is involving the large bronchi arising from the main or lobar branches ; it is bronchoscopically visible and most commonly lymph node involvement is present. Standard lobectomy cannot meet the minimum pathological requirements for extirpation of this lesion, and pneumonectomy may be precluded by the patient's age or poor cardiovascular function. The co-existence of
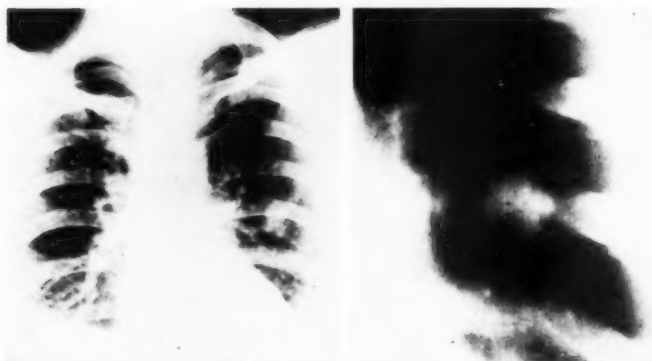
Fig. 1. Male aged fifty-one with carcinoma of left apical lower segment (a) P.A. radiograph (b) L. tomograph
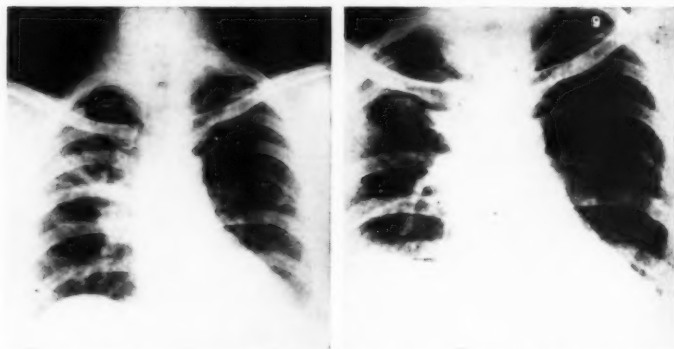
Fig. 2. Same patient two years later with carcinoma arising in the floor of the right upper lobe bronchus (a) Partial consolidation of right upper lobe, the left side being normal. (b) Same patient. Condition following resection of right upper lobe with right main bronchus, followed by anastomosis of the lower end of the main bronchus to the trachea.

bronchitis, emphysema, or other disease affecting the contralateral lung, restricts the amount of lung tissue which may be removed with safety. The increasing incidence of bronchial carcinoma in an ageing population, makes this an important consideration in the treatment of the individual patient.

It is under those circumstances that the operation of lobectomy, with sleeve resection of the main bronchus, has its place—since by this means removal of all tumour bearing tissue and lymph nodes may be carried out with resection of less than the entire lung. The following case history illustrates such circumstances:

A patient of fifty years of age was known to have had a small rounded opacity in the left mid zone since November 1951. At operation in June 1953 the left

apical lower segment was removed containing a small rounded mass which on section proved to be a well differentiated squamous lung carcinoma, without evidence of metastasis to the lymph nodes (Figs. 1*a* and *b*). The patient remained well for two years after his operation and then developed a cough, and a radiograph showed mottled shadowing in the right upper lobe (Figs. 2*a* and *b*). Bronchoscopy showed a nodular friable tumour mass in the posterior wall of the right upper lobe bronchus at its junction with the right main bronchus. Biopsy showed evidence of squamous carcinoma. In July 1955 a right thoracotomy was carried out and a carcinoma in the right upper lobe bronchus at its junction with the main bronchus was confirmed with consolidation of the anterior and posterior segments of the right upper lobe. In view of the previous left-sided resection, pneumonectomy was not possible and therefore right upper lobectomy with a sleeve of right main bronchus was carried out. The middle

Fig. 3. Same patient : Right main bronchus laid opon showing carcinoma just within the lumen of the upper lobe bronchus.

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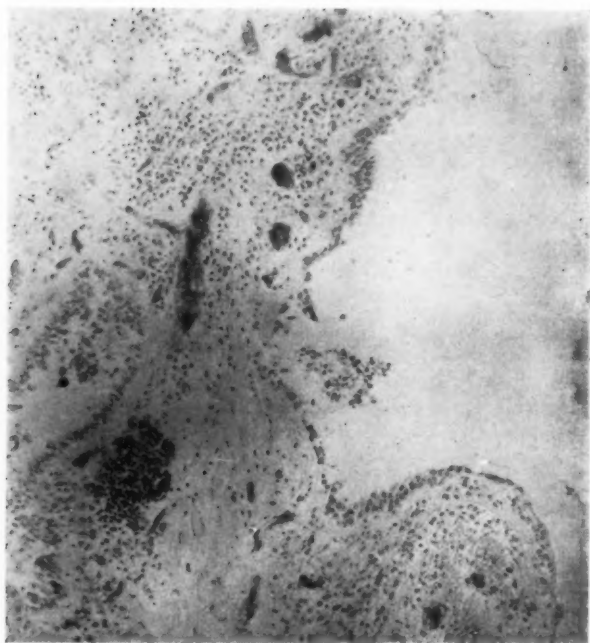
Fig. 4. Condition of the bronchial anastomosis at eleven months after operation.

and lower lobes were conserved by anastomosis to the cut end of the right main bronchus. The patient's post-operative progress was satisfactory apart from some pneumonic consolidation in the middle lobe which responded well to chemotherapy and postural drainage. Pathological examination of the specimen showed a well differentiated squamous carcinoma in the floor of the right upper lobe bronchus which had small metastases in the lobar lymph nodes (Fig. 3). The sleeve of main bronchus was sectioned and was found to be free of tumour at its cut proximal and distal ends. The patient made a perfectly satisfactory recovery following the operation. He remained quite well, although a little short of breath for over three years. He died last month from generalised skeletal, and soft tissue metastases.

The historical evolution of this procedure is of interest.

In 1947 Price Thomas performed a local resection for adenoma with a portion of the wall of the right upper lobe bronchus with reconstitution of the bronchial lumen. The resultant convalescence of the patient was without incident and satisfactory healing of the bronchial anastomosis occurred *per primam*.

In January 1952 he first performed a resection of the upper lobe and main bronchus for a tuberculous stricture, and he has repeated this operation on a number of occasions for benign tumours of both the right and the left main bronchi.

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His experiences have been recorded in the *Journal of the Royal College of Surgeons of Edinburgh* in December 1955, and they included for the first time a number of cases of bronchial carcinoma so treated.

An opportunity to study the healing process of bronchial anastomosis has subsequently arisen from post-mortem examination on three occasions. At four days a marked inflammatory reaction without epithelial regeneration is present. At seven months healing is well established with a thin layer of bronchial epithelium across the suture line. Slight inflammatory changes persist in the deeper layers. At eleven months the epithelial layer is three to four cells thick and no longer is there an inflammatory reaction present (Fig. 4). These last two patients died from cerebral metastasis.

In 1952 Allison successfully performed a radical lobectomy with sleeve resection of main bronchus and pulmonary artery for bronchial carcinoma.
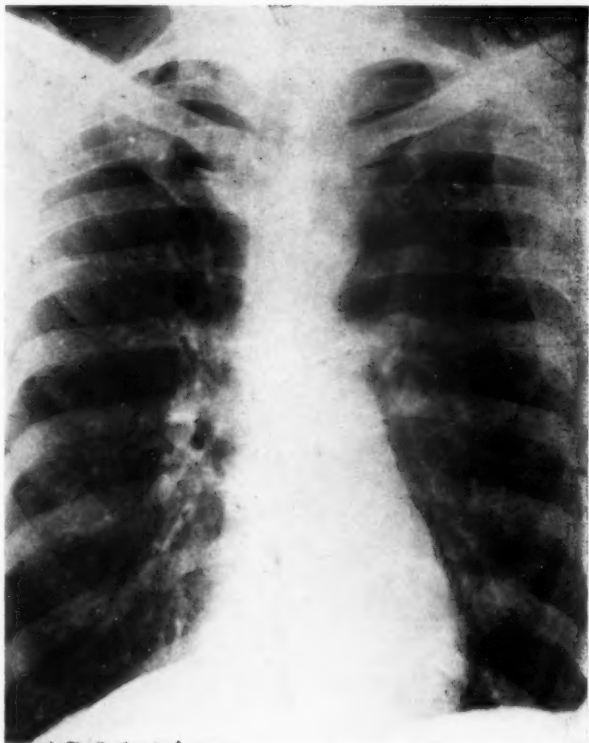
Fig. 5. Male patient, a known tuberculous subject (with cavitation at R. apex) complained of recent cough and haemoptysis (enlargement of left hilar shadow is present).

This is the first occasion where the operation was used in carcinoma of the bronchus and the first recorded instance of sleeve resection of both artery and bronchus.

The following case history is an example of the set of circumstances where it seemed indicated. This patient presented with a history of cough and recent haemoptysis. He was a known tuberculous subject and was under domicillary treatment for a tuberculous lesion at the right apex (Fig. 5). The sputum was negative. Radiograph showed an increase in the size of the hilar shadow and on bronchoscopy, 21st June, there was a nodular mass projecting from the left upper lobe orifice from which biopsy showed carcinoma (Fig. 6). At thoracotomy there was a tumour mass palpable at the left hilum close to the main bronchus, and there were two enlarged nodes in the aortic hollow. As pneumonectomy was to be avoided in view of the contralateral tuberculous lung, the left upper lobe was removed together with lengths of the left main bronchus and
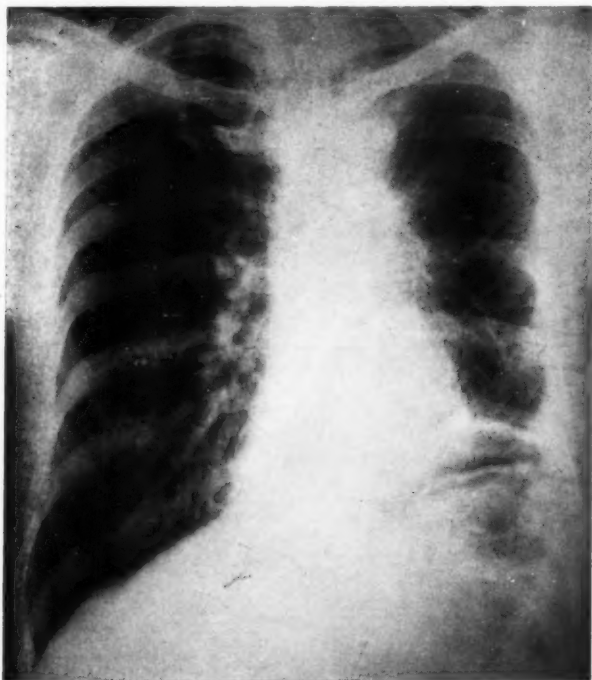
Fig. 6. Bronchoscopy showed squamous carcinoma in L.U.L. orifice encroaching on main bronchus. Radiograph following excision of left upper lobe and lengths of L. main bronchus and pulmonary artery which were seen to be involved by growth. Satisfactory aeration of left lower lobe following bronchial and arterial anastomosis.

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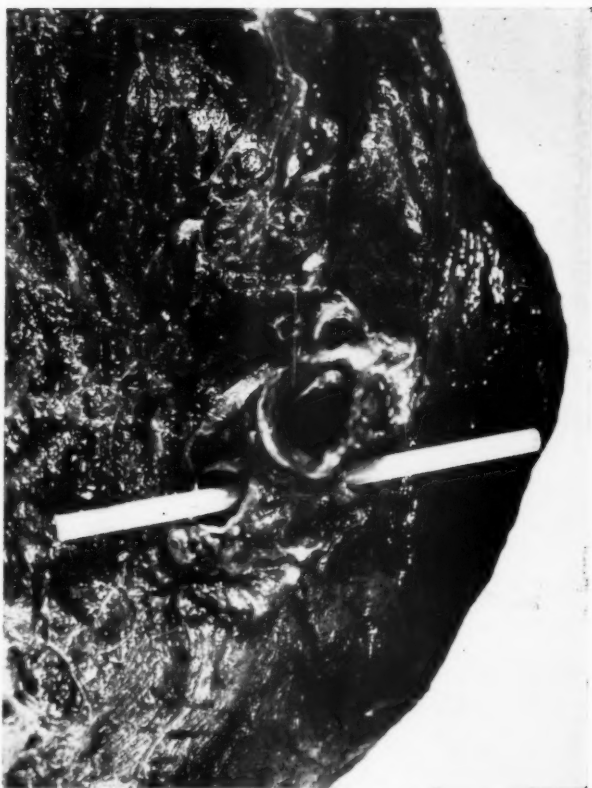
Fig. 7. Same patient, operation specimen, the glass rod passes through the main pulmon. artery and growth is seen in the sleeve of main L. bronchus.

left pulmonary artery which were clearly seen to be infiltrated by direct extension of the growth (Fig. 7). Continuity was re-established by direct vascular and bronchial suture, and the lower lobe showed satisfactory re-expansion in the post-operative period.

Angio-cardiography and lung function tests done at three months confirmed the functional activity of the lower lobe at that time (Fig. 8).

My own experience is confined to fifty-eight patients with bronchial carcinoma who have been treated by sleeve resection in the past four years. In these patients I have been concerned with the resection of less than an entire lung for bronchial carcinoma where it has appeared possible to remove all tumour bearing tissue by this procedure. Conservation of the residual pulmonary tissue has been achieved by implanting the

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3

Fig. 8. Selective angiocardiography at three months after operation confirms patency of L. main pulmon. artery.

lobar bronchus into the main stem bronchus. The first patient was operated upon in April 1955, at the London Chest Hospital, and the last in July 1958 :

TABLE V
58 CASES

Sex	..	.. Male	..	.. 53
		Female		.. 5
Age	..	.. under 50..	..	7
		50—59	..	.. 31
		over 60	..	.. 20

Fifty-three patients were male and five female. Fifty-one of the patients were in the sixth and seventh decades of life, and had lived in an industrial area characterised by a high incidence of bronchitis and emphysema.

TABLE VI
ASSOCIATED LUNG DISEASE

Chronic bronchitis ..	..	..	28
Emphysema ..	..	..	21
Pulmonary tuberculosis	..	..	7
Industrial disease ..	..	..	3
Contralateral cancer	..	..	2
Asthma ..	..	..	1

Depletion of pulmonary reserve was present in these patients and in three there was associated pulmonary fibrosis due to industrial lung

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disease, seven patients had contralateral pulmonary tuberculosis and in two, carcinoma of the other lung was present ; one patient was an asthmatic subject.

The site of the primary carcinoma was, in general, centrally placed so as to be bronchoscopically visible. It arose in the lobar bronchus and was placed in most instances so that involvement of the adjacent portion of main bronchus, either by direct extension or by compression from lymph node metastasis, had occurred. Adequate removal of the tumour by orthodox lobectomy under these circumstances would clearly be unsatisfactory and total pneumonectomy could not be undertaken without considerable hazard in view of the diminution in pulmonary reserve.

The type of operation performed is shown in Table 7.

TABLE VII
TYPE OF OPERATION

Portion of lung removed	Site of sleeve resection	Anastomosed structures	Number of patients
Right upper lobe ..	Main bronchus ..	Lower and middle lobes	17
Right upper and middle lobes ..	Main bronchus ..	Lower lobe ..	6
Right upper and middle lobes and apical lower segment	Main bronchus	Basal segments ..	3
Right upper lobe ..	Main bronchus and pulmonary artery	Lower lobe artery and bronchus ..	1
Left upper lobe ..	Main bronchus ..	Lower lobe ..	24
Left upper lobe and apical lower segment	Main bronchus ..	Basal segments ..	2
Left upper lobe ..	Main bronchus and pulmonary artery	Lower lobe artery and bronchus ..	2
Right upper lobe ..	Carina and left main bronchus.. ..	Right lower and middle lobes and left lung	1
Right lower and middle lobes ..	Main bronchus	Upper lobe ..	1
Left lower lobe ..	Main bronchus ..	Upper lobe ..	1
		Total ..	58

The right bronchial tree was involved in twenty-nine cases, of which 26 were arising in the right upper lobe bronchus ; in two, the right main bronchus at this level was the site of the growth. In one instance a right lower lobe tumour was present, which extended upwards to the level of the right upper lobe orifice. In the remaining cases, the site of the tumour, with one exception, was the left upper lobe and main bronchus. The exception was a case where a tumour mass, originally thought to be tracheal in origin, was found at operation to have arisen in the right upper lobe orifice and have crossed the carina to involve the proximal portion of the left main bronchus at its origin.

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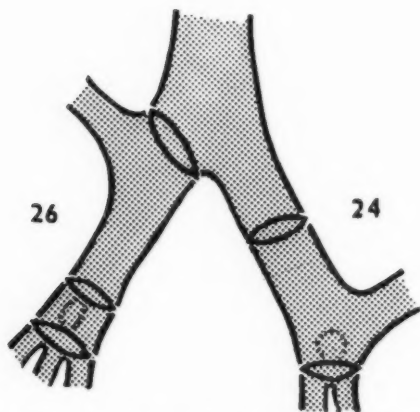
Fig. 9. Type of operation performed illustrated diagrammatically.

Pre-operative preparation entails elimination of infection in the bronchial tree with adequate chemotherapy and improvement in the patient's respiratory efficiency by physiotherapy. A short time devoted to these two factors is of a great value.

After Pentothal induction, gas and oxygen anaesthesia is maintained by means of a Carlins double lumen endotracheal tube.

After the chest is opened, the vascular lobar connections are freed, and the main bronchus both above and below the upper lobe bronchus is isolated, in order to determine whether or not the operation is feasible before any irrevocable step is taken. In like manner the portion of lung to be left *in situ* is carefully examined to exclude metastatic nodules or gross damage from inflammatory changes.

When it is decided that resection is possible, the superior pulmonary vein is divided between ligatures if necessary within the pericardium. The main bronchus is divided on the right side just below the carinal level, and on the left side about three quarters to one inch above the upper lobe bronchus. It is generally advisable to remove the paratracheal and parabronchial glands before undertaking bronchial section on the right side. This entails ligation and division of the azygos vein. The arteries to the upper lobe are then secured and the degree of involvement of the main artery is assessed so that a portion of this may be removed if necessary. Further development of the fissures, at this stage, allows the downward spread of the tumour to be assessed and the bronchus is now divided well below the lowest margin of the tumour. If necessary the main bronchus may be opened and the distal spread of the tumour determined by direct inspection from within the lumen. In order to achieve satisfactory clearance it was necessary to remove the middle

lobe as well as the upper lobe in six cases, and in three cases the apical segments also. To reduce tension on the suture line the lower lobe is mobilised by division of the inferior pulmonary ligament and separation from the diaphragm, if it be adherent. Occasionally further mobilisation may be necessary, and this is obtained by freeing the inferior pulmonary vein from the pericardium, care being taken to see that the vein is not
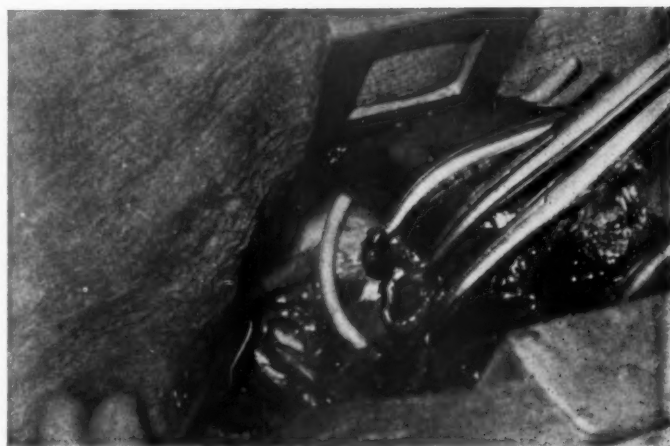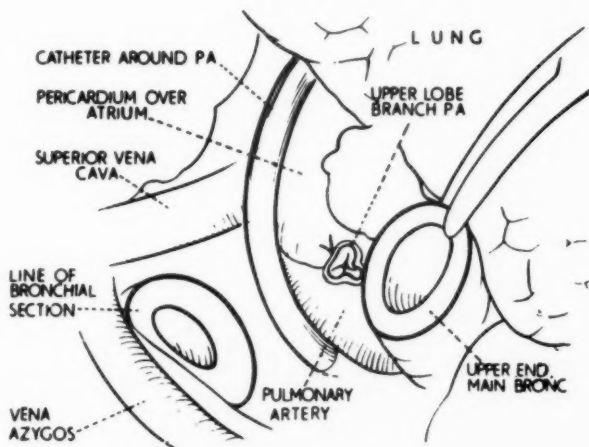
Fig. 10. Illustrations of steps in the operation of upper lobectomy with resection of the main bronchus.

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subsequently kinked over the edge of the pericardium when a further incision in the pericardium will be necessary.

Bronchial anastomosis is now performed with interrupted sutures, the approximation of the edges of the bronchi being as accurate as possible. Arterial anastomosis is performed after the bronchial in cases where a portion of the pulmonary artery has been removed.

In the post-operative period full and complete expansion of the residual lobe, so that the pleural space is obliterated and maintained so for the first few days, is an important matter in the smooth convalescence of the patients.

We have found that the use of continuous suction, through properly sited drainage tubes and twice daily radiological control, are important to ensure this end. Lateral films are essential, otherwise a fairly large anterior or posterior air pocket may easily be overlooked.

Fig. 11

Figs. 11 and 12. The vascular connections of the upper lobe, both arterial and venous, are first ligated and divided, and the main bronchus isolated above and below the take off of the upper lobe bronchus. The main bronchus is sectioned flush with the trachea and distally at or below the level of middle lobe bronchus and apical lower orifice. The glands in the paratracheal region and inferior tracheo-bronchial angle are excised. The upper lobe and main bronchus is removed, with lymph nodes, and the lower end of the main bronchus is anastomosed to the defect in the tracheal wall by interrupted sutures.

Operative Mortality

Six patients have died as a direct result of the operation.

TABLE VIII

Operation	Time after operation	Cause
L.U.L. Sleeve resection pulmonary artery and main bronchus	3 hours	No evident cause at post mortem
L.U.L. Sleeve resection main bronchus	6 weeks	Coronary thrombosis
R.U. and M. Lobectomy with sleeve resection	3 days	Sputum retention. Bronchopneumonia, respiratory insufficiency
R. U. and M. Lobectomy with sleeve resection	4 days	Sputum retention. Bronchopneumonia
R.U. Lobectomy and resection of artery and bronchus . .	3 months	Slough right lower lobe. Bronchial fistula. Thoracoplasty after residual pneumonectomy
R. U. Lobectomy with carina and part of left main bronchus	6 weeks	Haemoptysis — Paratracheal abscess

Fig. 12

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The first died three hours after operation without regaining consciousness. At post-mortem no obvious cause was found.

The second patient died from coronary thrombosis six weeks after operation. He was in his seventieth year, and his convalescence had been disturbed by transient episodes of auricular fibrillation.

The third and fourth patients died from respiratory insufficiency following broncho-pneumonia, resulting from sputum retention in the first two post-operative days.

The fifth case, following a right upper lobectomy and sleeve resection of the artery and bronchus, developed a necrosis of the lower lobe with the formation of a large bronchopleural fistula. After preliminary rib resection and drainage of the empyema, a residual pneumonectomy was carried out in order to remove the necrotic lobe, and a thoracoplasty was performed. This was unsuccessful, and the patient died from respiratory insufficiency. The sixth case was a patient in whom a growth had arisen in the right upper lobe bronchus and had spread by direct extension into the right main bronchus and across the carina to involve the proximal portion of the left main bronchus. It was originally thought to be tracheal in origin. The right upper lobe was removed, the adjacent portion of the right main bronchus, the carina and most of the circumference of the left main middle bronchus. Continuity was established by an anastomosis of the right intermediate and left main bronchus to the lower end of the trachea. After a stormy convalescence requiring tracheotomy in order to remove retained secretions, this patient died at six weeks from massive haemoptysis. Post-mortem examination revealed a large paratracheal abscess communicating with the right pleural cavity.

Post-operatively, in the early stages bronchoscopic aspiration, to deal with sputum retention with or without atelectasis, was required on five occasions.

TABLE IX
EARLY POST-OPERATIVE MORBIDITY

Atelectasis requiring bronchoscopy	5
Persistent pleural air space	1
Pneumonia in anastomosed lobe	1
Auricular fibrillation	5

Later the main problem has been to deal with excess granulation tissue or extruded sutures at the line of anastomosis. Hence the necessity for accurate coaption of the bronchial margins. One patient has developed a stenosis which has responded satisfactorily to two bronchoscopic dilatations. She has remained free from symptoms for the past six months.

TABLE X
LATE POST-OPERATIVE MORBIDITY

Sutures removed or coughed up	7
Granulation tissue at suture line	2
Haemoptysis due to above	2
Stenosis	1

In considering the pathology, the follow-up and the survival of these patients, I should like to point out that with characteristic generosity Sir Clement Price Thomas has placed his personal results at my disposal, enabling certain conclusions to be drawn from a study of ninety-eight patients, who have been thus treated in the past five years. The type of operation which has been performed is shown.

TABLE XI
Type of Operation Performed

R.U.L.+Sleeve	47
R.U.L.+R.M.L.+Sleeve	12
R.U.L.+R.M.L.+Apical Lower ⎱	2
+Sleeve ⎰	
R.M.L.+R.L.L.+Sleeve	2
L.U.L.+Sleeve	30
L.U.L.+Apical Lower+Sleeve	4
R.U.L.+Sleeve+Sleeve L. Main	1

TABLE XII
Additional Structures Removed

—with chest wall	3
—with sleeve pul. artery	5
—with segment pul. artery	3

Four pathologists have been concerned with examination of the specimens. All cases are histologically proven bronchial carcinoma and the specimens have been carefully examined with particular attention paid to the appearances at the ends of the sleeve of main bronchus. Histologically the lesions were distributed as shown.

TABLE XIII
Histological Type of Carcinoma

		Glands Involved
Squamous	69 ..	25
Undifferentiated	15 ..	5
Adenocarcinoma	12 ..	2
Metastatic Adeno	2 ..	1

Diagramatic Representation

In one instance only was there evidence that the growth had extended proximally to the line of section of the main bronchus, in most cases there was as much as 1cm. of free bronchus on either side of the growth.

The follow-up of these patients is short and can only provide limited information. Of the ninety-eight patients it is known that twenty-nine are dead, and a further six, who are living, are known to have a recurrence of disease.

TABLE XIV
Follow up of Patients

Total	98
Alive	69
Alive with Recurrence	6
Dead	29

Of those who are dead eight have died as a result of the operations. Nineteen died from recurrence of the carcinoma and the remaining two patients showed no evidence of carcinoma at the autopsy.

TABLE XV
DEATHS

Operative	8
Other causes	2
Recurrence of Carcinoma	19

Death was due to coronary thrombosis in one, and to progressive cor pulmonale in the second. It has not been possible to establish the exact site of recurrence in other instances, but we have positive evidence of recurrence as shown.

TABLE XVI
RECURRENCE OF CARCINOMA

Bronchus	2
Chest elsewhere	6
Supraclavicular	2
Distant	7

The survival figures of these patients have been investigated from the point of view of length of survival and also its quality.

TABLE XVII
LENGTH OF SURVIVAL

Three years or more	2
Two years or more	9
One year or more	52

Five patients have been operated on more than three years ago and two are alive. Fifteen patients have been operated on more than two years ago, but less than three, and of these nine are alive at the end of two years. Sixty-five patients have been operated on more than one year ago, and of these fifty-two (that is 80 per cent.) are alive at one year. In a personal series of 114 cases of standard lobectomy for carcinoma, Price Thomas found that seventy-four per cent. were alive after one year.

TABLE XVIII
COMPARISON OF SLEEVE AND STANDARD LOBECTOMY

Per cent alive after one year	80%
Per cent of 114 Lobectomies alive after one year	74%

The quality of survival is less easy to estimate. Apart from one patient, who has died of progressive right ventricular failure some months after his operation, few of the patients are more disabled following their operations. It is fair to say that most of the surviving patients have been restored to their pre-operative functional capacity, and are back at work. There have been two instances where dyspnoea has been greatly relieved. Differential lung function, carried out on four patients at varying times following the operations, furnished incomplete information, but it can be seen that the anastomosed lobe continues to have a ventilatory function and oxygen uptake.

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TABLE XIX

DIFFERENTIAL LUNG FUNCTION AFTER OPERATION

% Ventilation   %O_2 uptake

Case No.	Normal lung	Operated lung	Normal lung	Operated lung
1	R 69	L 31	73·3	26·7
2	L 66·4	R 33·6	69·5	30·5
3	R 60·5	L 39·5	64·8	35·2
4	R 68	L 32	69·8	30·2

Case three shows function to continue after bronchial and arterial anastomosis.

Finally it has been shown that pneumonectomy in elderly or unfit subjects has a formidable mortality and morbidity.

TABLE XX

MORTALITY AFTER PNEUMONECTOMY (Adams)

Age	Pneumonectomy	Dead
60+	70	18 25·7%
50—59	76	12 15·7%
49—	50	1 2%

If standard lobectomy is not possible, surely lobectomy with sleeve resection should be employed whenever circumstances permit, before performing total lung resection on these patients.

In conclusion this experience supports the view, firstly, that the operation is reasonably safe, secondly, the early follow-up results are no worse than conventional treatment, and thirdly, with this operation technique available, it is now possible to accept for surgical treatment a higher percentage of patients than before.

The debt, which I owe to Sir Clement Price Thomas, cannot adequately be measured. It should be recalled that having carried out what was probably the first dissection pneumonectomy for bronchial carcinoma in this country in March, 1935, he has devised and evolved this present surgical procedure, the value of which is beyond doubt. It must surely take its rightful place as the operation of election, when simple lobectomy is not possible, in all patients over sixty years of age who develop carcinoma of the bronchus. In these circumstances, total ablation of one of the organs of respiration, if it be the seat of malignant neoplasm, can only be justified if all lesser operations have failed.

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APPOINTMENT OF FELLOWS AND MEMBERS TO CONSULTANT POSTS

B. N. COLABAWALLA, F.R.C.S.	Honorary Asst. Surgeon to St. George's Hospital, Bombay.
G. L. D. FORDYCE, F.D.S.R.C.S.	Dental Surgeon to Mount Vernon Centre for Plastic Surgery and Jaw Injuries.
BERYL M. GOETZEE, F.F.A.R.C.S.	Consultant Anaesthetist to Royal London Homoeopathic Hospital.
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D. C. BEATTY, M.R.C.S., M.R.C.P.	Consultant Physician in Physical Medicine to St. Albans City, Queen Victoria Welwyn and Harpenden Memorial Hospitals.
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W. H. LONSDALE, F.R.C.S.	Consultant Surgeon to Preston and Chorley Group of Hospitals.

The Editor is always glad to receive details of new appointments obtained by Fellows and Members, either through the Hospital Boards or direct.

HETEROTRANSPLANTATION OF HUMAN TUMOURS AND TISSUES

by

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Imperial Cancer Research Fund

THE SUCCESSFUL TRANSFER of tissues from one host to another depends on a number of factors but in particular on the constitutional relationship of donor and recipient. Grafts of normal and malignant tissues will persist if inoculations are made within a genetically homogeneous population but destruction of the graft is the rule if it is made outside such populations. The ability of a transplanted tumour to grow progressively in the new host depends primarily on the simultaneous presence of certain genetic determinants called *histocompatibility factors* in the host and in the transplant. This genetic basis of susceptibility and resistance to transplanted tumours was established by using inbred strains of mice (Bittner, 1935 ; Hauschka, 1952 ; Snell, 1952 ; Gorer, 1956 ; Little, 1956).

An autotransplant, or autograft, is one in which a tissue is grafted from one site to another in the same animal.

With tumours, Willis (1952) reviewed the methods by which this may occur in man, either spontaneously—as in contact carcinoma of opposed surfaces—or in inoculation metastasis along the bronchi, genital or urinary tract, or in operation scars after surgical interference with tumours. Recently, Pannet (1957) has drawn attention to Keynes' observations that carcinoma was apt to grow in the scar resulting from a biopsy taken during removal of radium needles around a breast tumour. Strictly speaking, all metastases are autotransplants.

An isotransplant (Snell, 1959)—or Isogenic transplant (Gorer, 1959)—is one between animals of the same strain which have been closely inbred by brother-sister matings for twenty or more consecutive generations, so that the individuals are genetically identical.

A homotransplant is one between individuals of the same species but of different genotypes, for example, man to man.

A heterotransplant is one between different species, for example, man to mouse. The general aspects of the heterologous transplantation of cancer have been reviewed by Ahlström (1957).

There are several laws governing the transplantation of neoplastic and normal tissues (Snell, 1952) but only two need concern us here :

1. Transplants within a single inbred strain, that is, *isografts* (isogenic grafts) *will in general be accepted by the host.*

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2. Transplants between strains, that is, *homografts will be destroyed by the host after an initial period of survival.*

Like homografts, heterografts also will be destroyed unless the resistance of the host to the foreign tissue is impaired in some way so that the host-graft relationship is altered, or unless the graft is transplanted to a special site in the host, or unless the host animal is an exception to the general genetic laws governing transplantation.

In 1900, Sailer concluded that the transmission of tumours to lower animals from human beings may be regarded as absolutely impossible unless some profound modification in technique, or in the preparation of the animals subjected to the experiments, could be devised. This prophecy, for the very reasons he gave, has been partially fulfilled. Malignant cells derived originally from human tumours can be propagated indefinitely using special techniques or suitably prepared animals. This type of cell culture must, of course, be regarded as a form of artificial metastasis, although some attempts are now being made to transmit cancer to animals with cell-free extracts of human tumours (to be discussed later, see page 52).

In 1914, Murphy showed that X-irradiation reduced the resistance of the host animal so that it would accept grafts from other species, and this observation has now been amply confirmed (Clemmesen, 1938).

During the last few years considerable interest has been shown by some surgeons, experimental pathologists and biologists in the possibilities of transplanting human tumours and normal tissues from operation or autopsy specimens into laboratory animals. Many investigators (Toolan, 1954a, 1957a ; Handler, Davis and Sommers, 1956 ; Patterson and Patterson, 1956 ; Patterson, Patterson and Chute, 1957 ; Skiff, *et al.*, 1958) have succeeded in obtaining a few human tumours which can be serially propagated in X-irradiated or cortisone acetate treated rats or hamsters—that is, conditioned animals. Toolan (1953) has reviewed some of the methods used in conditioning the host. Much of the early work on the transplantation of animal tumours was carried out by Bashford (1905) and his colleagues in the laboratories of the Imperial Cancer Research Fund, and Craigie (1949) has applied a quantitative approach to the study of transplanted tumour cells and their response to various artificial environments.

Brent (1958) outlined some of the problems of the homograft reaction (particularly for skin and other normal tissues) which he has described as one of the most profound and challenging of biological problems fascinating experimental biologists and pathologists.

Some of the factors which are important in establishing successful homografts or heterografts, and some of the methods used to overcome histocompatibility barriers are shown in Table I ; they are grouped together in this form for convenience in description :

TABLE I

HOST-GRAFT RELATIONSHIPS

Animal

Site
Sex
Age

Graft

Pre-treatment. Passage : (i) Zig-zag
                          (ii) Adaptation
Diffusion chambers : (1) Natural
                        (2) Artificial

Dose

Host

Dyes
Radiation
Hormones
Immunological paralysis
Enhancement
Acquired tolerance
Other methods

SPECIES AND STRAIN OF ANIMAL

One of Toolan's (1954*a*) permanently transplantable human tumours is H.Ep. 3. This was originally removed from a sixty-two-years-old coloured patient who had a two years' history of leukoplakia prior to the appearance of a tumour nodule in the buccal mucosa which metastasised to lymph nodes in the neck. Portions of this tumour were grown by Toolan in rats and hamsters for many generations, and it is the fastest growing and most invasive neoplasm of the tumours on which she has published detailed reports.

Gallily and Woolley (1958) compared the growth of this tumour in three different inbred strains of conditioned mice. They found, as judged by serial transfer, that growth was best in the DBA/2 strain of mouse and concluded that, in their experiment, mice of different strains did not display the same blocking of immunological response even though they had received the same conditioning treatment. Toolan (1957) had previously reported a greater proportion of successful heterotransplants of human tumours in DBA and LAF mice.

The hamster also appears to be a suitable animal for heterotransplantation studies. In the Biology and Pathology Departments of Harvard University, Boston, U.S.A., several workers have made extensive studies of the anatomy, circulation and growth of tumours in the hamster cheek pouch. Fulton, Jackson and Lutz (1947) studied the anatomy of the hamster cheek pouch which is a useful site for transplantation. It is a paired structure, located inside the mouth cavity, and used for temporary storage of food. The normal pouch is approximately $1\frac{1}{2}$ inches in length, extends posteriorly to a position near the shoulder, and is lined with stratified squamous epithelium. There is a layer of fibrous connective tissue beneath the epithelium and longitudinally arranged muscle fibres are numerous at the edge of this layer, near the open end of the pouch, but are absent at the blind end. Human tumours have been grown at

either end of the pouch, for blood vessels are numerous in both connecti e tissue and muscle layers. When the pouch is everted by gentle traction with blunt-ended forceps the loose connective tissue of the pouch wall separates and grafts can be inserted between the two layers of the pouch. The main advantages of using this site are that grafts can be seen and measured easily or photographic records made; the disadvantages are that the technique of transplantation is more time-consuming, infection is more likely to occur, and there are natural limits to the size of the tumour that can be grown.

Even with subcutaneous tumour inoculation it is important to remember that small differences in technique may be responsible for variations in subsequent tumour growth. Working with a transplantable, chemically-induced hamster sarcoma, Crabb (1946) described some of the technical details involved in transplanting this tumour in the hamster. In 1957, Patterson, Lyman and Patterson found that human tumour growth was inhibited during hibernation of the hamsters.

The studies of Adams, Patt and Lutz (1956) have been extended by Billingham and Hildemann (1958a) who have shown that intra-colony
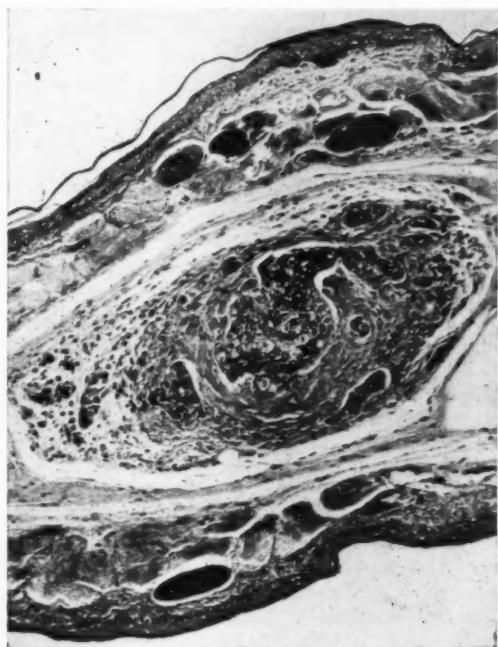
Fig. 1. Section through the cheek pouch of a cortisone acetate treated hamster transplanted twenty days previously with a human breast cancer. Stained H. and E. ×100.
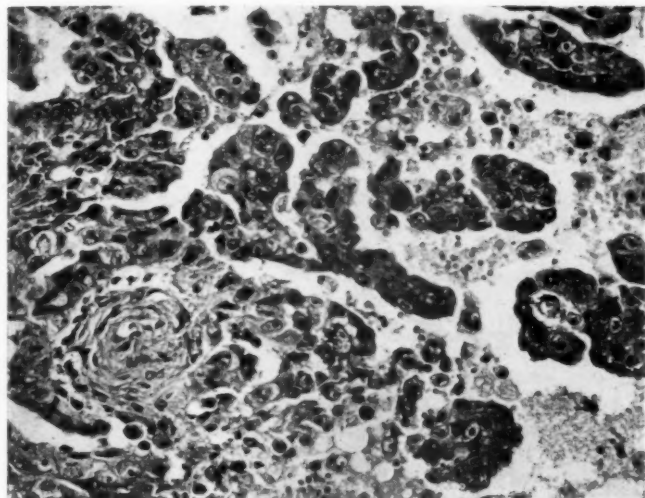
Fig. 2. Embryonal carcinoma (Pitt 61) growing in the peritoneal cavity of a cortisone acetate treated hamster. Stained H. and E. ×250.

homografts of skin can be successfully transplanted in hamsters that are not inbred. It is suggested that there is an apparent paucity of strong transplantation antigens distinguishing the hamster from all other mammals thus far studied. Transplacental exchanges of cells may occur in hamsters but the intra-strain acceptance of skin homografts has not yet been shown to be a result of this naturally-acquired tolerance (Billingham and Hildemann, 1958b). Tolerance is considered later in this paper (see page 51).

Several human tumours can now be serially propagated in conditioned hamsters, but human tumours of the breast and prostate, in my experience, do not survive repeated transplantation. Figure 1 shows a section through a hamster cheek pouch. Between the two layers of epithelium and muscle lies a fragment of a human breast cancer, twenty days after transplantation to this cortisone acetate treated hamster. This tumour was originally isolated and transferred to conditioned hamsters by Dr. Patterson of Boston, but I have failed to propagate it by serial passage. It may be that mice bearing transplantable pituitary endocrine-secreting tumours (as described by Furth, Gadsen and Upton, 1953) would be a more suitable host for propagating human breast tumours. It is of interest to note here that Pierce, Dixon and Verney (1958) have established several permanently transplantable human testicular tumours which produce chorionic gonadotrophin. These cause polycystic ovaries and enlarged uteri in their conditioned hamster hosts. Figure 2 shows the

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morphology of an embryonal carcinoma, Pitt 61, growing in the peritoneal cavity of a cortisone acetate treated hamster.

Transplantation site

Various workers have used the brain or the anterior chamber of the eye for transplants of both tumours and normal tissues, references to the literature are quoted by Chesterman (1955) and by Ahlström (1957). These sites afford some protection from the immune response of the host. Medawar (1948) found that skin homografts transplanted to the brain could not elicit an immune state but would succumb to one already in existence. I have implanted material from twenty human tumours intra-cranially into a series of 180 mice; growth was observed in three cases only, all from lung cancer. Fig. 3 is a coronal section through the head
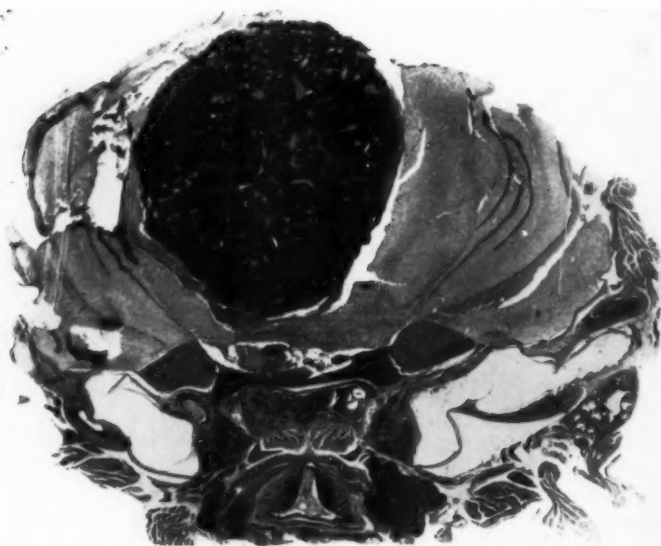
Fig. 3. Coronal section through the head of a mouse showing a vascularised human oat-cell carcinoma sixty-six days after implantation. Stained H. and E. ×15.

of a mouse showing the growth from one of these human lung tumours, sixty-six days after inoculation. There is a well vascularised healthy tumour in the brain expanding the overlying skull. Histological sections showed an oat cell carcinoma similar to the patient's original tumour. He had an oat cell type carcinoma of the bronchus which was treated with radiotherapy; six months later six subcutaneous nodules developed, the largest being removed under local anaesthesia. Scrapings from the cut

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surface of this metastatic tumour were used for intracranial trans-plantation.   Human breast tumours in mouse brain, however, show little or no evidence of growth. Many of the implants become converted into a hyaline mass which is often vascularised. It is possible, of course, that malignant cells are lying dormant and unrecognised in this stroma and are not receiving the necessary stimuli for active growth. Lumb (1954) was unable to demonstrate growth from intracerebral transplants in mice of twenty-seven human breast carcinomata.

The eye is another site that is commonly used for heterotransplantation, especially by Greene (1952). The anterior chamber of the rabbit or guinea-pig eye has several advantages. Schilling, Snell and Favata (1949) found that the guinea-pig eye was resistant to the growth of ordinary bacterial contaminants that are invariably present even in the most carefully selected specimens. Albrink and Wallace (1951) reported that the ionic differences between aqueous humor and serum are small and within limits tolerated by living cells. There is a very low protein and very low antibody content. Pure aqueous humor from beef eyes will support survival and limited growth of chick fibroblasts.

I have been unable to confirm Greene's (1953) success in attempts to establish human lung tumours in the anterior chamber of the guinea-pig eye but the human sarcoma HS1 (Toolan, 1954a) has grown in the eye in more than 30 per cent. of the animals implanted and HSI cells have also survived in the guinea-pig cornea ten days after inoculation.

Other sites that have yet to be proved to be " immunologically privileged " are the hamster cheek pouch, the seminal vesicle (Katsh, 1958) and the testis. Aron (1953) demonstrated survival of some human tumours in the testes of guinea-pigs, and Snell (1953) suggested that intra-testicular grafts, like intra-cerebral grafts, are susceptible to antibodies but are not efficient in stimulating their formation. The allantoic membrane of embryonated eggs is a suitable site for transplantation of human tumours for short term experiments. Sommers, Sullivan and Warren (1952) found that twenty-eight of fifty-nine different human cancers successfully survived transplantation to the chorioallantoic membranes of chicken egg embryos. Some human tumours that have been propagated in conditioned rats can be grown by serial transplantation in embryonated eggs (Dagg, et al., 1954).

Sex

So far with heterotransplants of human tissue the sex of the recipient has not appeared to influence the survival of the graft. An alteration in growth of Ehrlich's mouse ascites carcinoma on repeated transfer through hamsters has been demonstrated by Ahlström and his colleagues (Ahlström and Ising, 1954; Ahlström and Stormby, 1958). In the early stage of adaptation to the hamster the tumour grew better in female hamsters than in males but no such sex difference was demonstrable in the final hamster-adapted tumour. Eichwald, Silmser and Weissman (1957)

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have demonstrated rejection of male isografts of skin by female mice. Negroni (personal communication), working in the Imperial Cancer Research Fund Laboratories, has found that one-month old C3H mice, both male and female, inoculated with leukaemic cells from *male* leukaemic AK mice do not develop leukaemia until about four months after the inoculation. Leukaemic cells from these C3H mice are transplantable only into C3H mice, not into AK mice. No leukaemia has been observed in our colony of uninoculated C3H mice at the age of five months. Leukaemic cells from *female* AK mice inoculated subcutaneously into C3H mice, both male and female, produce a tumour at the site of inoculation in about 30 per cent. of the recipients. The tumours are palpable two weeks after inoculation and the animals die from generalised leukaemia about a month later. Leukaemic cells from these animals can be transplanted to both C3H mice and AK mice and the hosts die from generalised leukaemia in three weeks. There are two conclusions which can be drawn from these results. Firstly, there seems to be a difference between leukaemic cells derived from male AK mice and those derived from female AK mice. Secondly, leukaemia which develops at the age of five months—a long period after the inoculation—has probably not developed from the cells used for the inoculation.

Age

Toolan (1958*a*) found that the weanling rat was affected more by irradiation than adults of any age, and that the growth of transplantable human tumours was better in these conditioned weanling animals. I have found that Human Sarcoma 1 (Toolan, 1954*a*) grows in some cortisone acetate treated animals of all ages between one and eight months, the latter being the oldest animals yet studied, but growth is more rapid, and regression delayed, in the younger animals. Table II shows the amount of this tumour grown intraperitoneally in cortisone acetate treated hamsters at different ages.

TABLE II

HUMAN SARCOMA 1—FEMALE IPI HAMSTERS

	Age in weeks	Initial weight (gms.)	AFTER 16 DAYS : Weight when killed (gms.)		
			Hamster	Tumour	Hamster + Tumour
Treated with Cortisone acetate	6	59	47.0	7.8	54.8
No treatment	6	60	76.0		76.0
Treated with Cortisone acetate	30	135	133.0	1.8	134.8
No treatment	30	140	142.0		142.0

The figures in the last four columns represent the mean weight of five hamsters used for each experiment.

Six weeks old hamsters are still growing but when treated with cortisone acetate they fail to gain, or may lose weight. In untreated adult hamsters, regression and death of the tumour occurs generally after fourteen days, and always by twenty-one days. If hamsters are inoculated with HS1 within forty-eight hours of birth, there is initial growth, sometimes extensive, followed later by regression which may be delayed for periods between fourteen and fifty days (Chesterman, 1959). In one instance the large size of the tumour at thirty-one days necessitated killing the animal. In all, fifty-one hamsters from eight litters were inoculated. Forty of these were alive two weeks later, and seventeen of these had tumours of varying size at the inoculation site. Fourteen of the animals failed to thrive and to grow normally ; some of them had a pug-face appearance and abnormalities of the teeth. This type of cachexia was at first thought to be due to a graft-versus-host reaction as a result of adult lymphoid tissue accidentally inoculated with the HS1 tumour. However, histological examination has not shown any marked atrophy of lymphoid tissue in these runts and it is probably a non-specific toxic effect.

Dagg, Karnofsky and Roddy (1956) were unable to grow HS1 after subcutaneous injection of tumour suspensions into chicks up to three days old but found that another of Toolan's tumours, H.Ep.3, grew and later regressed after inoculation into young chicks. They also found that if the tumour was grafted on to the chorionallantoic membrane of fertile chicken eggs, growth occurred in the embryo and also in the chicks after hatching.

Gallagher and Korson (1959) have been able to propagate Human Epidermoid Carcinoma 3 (Toolan, 1954a) in untreated rats inoculated *in utero*.

CONDITION AND CONDITIONING OF THE GRAFT

" *Pre-treatment* " is the experimental interference that the graft has undergone before transplantation. For example, the size of the tumour in, and the time of removal from, the previous host ; the effect of cold storage, or whether the tumour is taken directly from the patient, or has already been passed several times in conditioned hosts, or in tissue, or organ culture. From the work of Craigie (1954) it is well known that animal tumours can survive for many years in the frozen state at —79°C. Established transplantable human tumours vary in their survival after cold storage according to the method of freezing (Toolan, Haemmerli and Korngold, 1957) but no ensuing antigenic loss has so far been demonstrated.

The majority of heterotransplants made by Greene at Yale were of tumours transferred in sterile containers from the operating theatre to the pathology laboratory within a few hours. Some tumours could be successfully transplanted after ninety hours' storage at ice-box

temperature. In a series of nine transplantable human tumours studied by Patterson and Patterson (1957) survival was reported after storage for forty-eight hours in sterile humidified Petri dishes at room temperature ; seven survived for twenty-four hours ; three for forty-eight hours, but none for seventy-two hours.

By " zig-zag " or alternate transplantation between rat and mouse, Ehrlich (1907) was able to cultivate a mouse tumour through fourteen transfers. Using a similar process of adaptation, Ahlström and Ising (1954) made multiple passages of the Ehrlich mouse ascites carcinoma through hamsters with an occasional passage through mice. The eighth serial passage through hamsters was continued for twenty-nine serial passages without the need for a mouse passage. This hamster-adapted tumour then grew significantly better in hamsters than the non-adapted tumour, and the non-adapted tumour grew better in mice than the hamster-adapted tumour.

Diffusion chambers

1. *Natural.* The lens, the cornea, and cartilage are avascular structures and might be considered as naturally-occurring diffusion chambers where fluid can pass through to nourish a graft placed in them but where host cells are prevented from penetrating and destroying the graft. In 1950, Morris, McDonald and Mann found that transplants of four malignant tumours and one specimen of normal tissue survived within the lens of the eye of five guinea-pigs and in at least one case the transplant grew. With heterotransplants of animal tumours, Franks (1957) has demonstrated survival of mouse tumours in the lens of guinea-pigs' eyes for periods up to twelve weeks after inoculation.

2. *Artificial.* Algire, Borders and Evans (1958) have sealed explants of several surgical specimens of human tumours into artificial diffusion chambers made of porous membranes. These chambers have then been introduced into the subcutaneous space or peritoneal cavity of untreated host animals. They concluded that short-term experimental studies of human cells were practicable under these conditions.

Dose

Before any tumour will take after transplantation, a minimum number of viable cells is necessary in the inoculum. Marsh and Cullen (1958) found that with human sarcoma (HS1) in conditioned rats, tumours growing from 1 ml. of inoculum are not significantly larger than those grown from half this amount. Foley and Handler (1957) have shown, by quantitated inocula of fourteen tissue culture cell lines which are similar *in vitro,* that all cell lines grew in the cheek pouch when 1×10^6 cells were implanted but only those cell lines derived from neoplastic tissue produced tumours when the inoculum contained 1×10^4 cells.

METHODS OF CONDITIONING THE HOST

Dyes

Dyes such as trypan blue and vital red have been used in attempts to depress host resistance by blocking the reticulo-endothelial system but these methods have not proved successful with human tumour heterografts.

Radiation

Whole body x-irradiation, particularly of weanling animals, impairs immunity to heterologous grafts of malignant and normal human tissues. Much of the pioneer work in transplanting human tumours to irradiated and cortisone-treated rats has been carried out by Toolan of the Sloan-Kettering Institute. After screening over one thousand tumours she now has several human sarcomas and carcinomas which are passaged routinely and used for chemotherapy or other experiments. Herbut and Kraemer (1956a) transplanted 206 malignant human tumours subcutaneously into irradiated weanling rats (receiving 150 r) and treated with cortisone (3 mg. doses). Growth occurred in only one instance—that of an anaplastic carcinoma from the ascending colon of a seventy-seven-years-old woman. This tumour has also been successfully transplanted into animals receiving irradiation alone (150 r to 300 r) or cortisone (6 mg. doses) alone. It has not been successfully transplanted into untreated normal animals. These workers also conditioned the animals with zymosan but found this method less effective than irradiation (Herbut and Kraemer, 1956b). Later studies showed that the natural resistance of weanling Wistar rats to the growth of this human colonic carcinoma was not mediated through the properdin system (Herbut, et al., 1958). Radio-active isotopes have been used successfully (Bollag and Meyer, 1954) in transferring the Crocker Sarcoma from mice to rats.

Hormones

The preparation in common use is cortisone acetate, either alone or in combination with irradiation where in rats it acts synergistically (Toolan, 1958a). Among its known effects in the hamster are diminution of the lymphoid tissues and circulating lymphocytes (Crabb and Kelsall, 1951). In rats, Weaver (1955) has shown specific destructive changes in the thymus and lymph nodes after cortisone and corticotrophin treatment. Scothorne (1956) used skin homografts in rabbits and suggested that cortisone acts primarily on the graft, in some way preventing the graft from exerting its antigenic effect upon the regional node and thereby impairing the development of the systemic immune response. On the other hand, Toolan (1958b) has drawn attention to the effects of cortisone on the connective tissue ground substance and the connective tissue reactions to homologous and heterologous tumour transplantation have been studied by Vasiliev (1958a). The effect of other adrenal steroids and of cortico-trophins on the growth of HS1 in weanling rats has been reported by Buttle and his co-workers (1959). They found that this tumour will not

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develop in untreated weanling animals. Cortisone acetate, hydrocortisone acetate, prednisolone and 9∝ Fluorohydrocortisone acetate promoted the growth of the tumour but deoxycorticosterone acetate was ineffective.

TABLE III

The Effect of Endocrine Removal and Replacement Therapy on the Growth of H.S.1 in Weanling Rats

(Data kindly supplied by Buttle and his colleagues—based on original work not yet published)

Treatment	Tumour Growth
Cortisone acetate :	
20 mg./100 g. body weight × 4 subcut	Growth
Adrenalectomy	No growth
Adrenalectomy + Cortisone acetate	Growth
Adrenalectomy + Corticotrophin	No growth
Hypophysectomy	Rats died (no evidence of growth)
Hypophysectomy + Cortisone acetate	Growth
Hypophysectomy + Corticotrophin	Growth

The tumour failed to develop in untreated adrenalectomised or hypo-physectomised animals but grew if they were treated with cortisone acetate. Corticotrophin was without effect in adrenalectomised rats but would promote tumour growth after hypophysectomy. In intact corticotrophin-treated rats some correlation existed between tumour size and adrenal hypertrophy. Tumours failed to develop in rats with adrenal glands smaller than about 30 mg. (approximately three times normal size), while marked tumour development occurred in rats with adrenals weighing more than 50 mg. Buttle and his colleagues therefore concluded that the effect of corticotrophin on growth of this tumour is mediated by the adrenal cortex.

Certain complications may arise following the use of conditioning agents, such as cortisone, which have a non-specific depression of immunity. Chute, Kenton and Sommers (1954) reported an unexpected infection of hamsters with tubercle bacilli after inoculation with material from the prostate gland removed at biopsy from a man with bilateral pulmonary tuberculosis. I have seen generalised tuberculosis associated with torulosis in a few hamsters inoculated with material from a patient with carcinoma of the lung and tuberculosis. Many of the torulae were calcified. Cox and Tolhurst (1946) reported that calcification occurs more frequently in animal than in human infections. Franks (personal communication) has also seen tuberculous granulation tissue in the anterior chamber of the guinea-pig eye following inoculation with tumour material from a para-rectal lymph node from a patient with rectal cancer and pulmonary tuberculosis.

" Immunological Paralysis " was the term used by Felton (1949) to describe the impairment of immunity caused by injecting adult mice with relatively large doses of type-specific pneumococcal polysaccharide.

The non-specific mucopolysaccharide, zymosan, has given variable results in breaking down immunity to heterografts used either alone (Jude and Schatten, 1958) or in combination with cortisone acetate (Herbut and Kraemer, 1956b.)

Enhancement

Green (1958) uses the general term " enhancing factor " to include all those tumours and normal tissue agents which accelerate the growth of, and/or impair resistance to transplanted tumours. Kaliss (1957) has shown that host resistance in mice can be reduced by prior injection of mouse tissue antisera prepared from rabbits and mice, and he applied the term " immunological enhancement " specifically to the establishment of a tumour homograft (Kaliss, 1958) and its progressive growth as a consequence of the tumour's contact with specific antisera in the host. So far I have failed to show any enhancement of growth of HS1 in hamsters treated with various doses of antisera to HS1 prepared in rabbits. It has been shown (Pikovski and Schlesinger, 1956) that grafts of a mouse mammary carcinoma can result in tumours in 100 per cent. of rats pretreated with doses of lyophilised mouse tumours or some normal mouse tissues.

Actively acquired tolerance

The work of Billingham, Brent and Medawar (1956) demonstrated that in certain host-graft relationships, for example, skin homografts in mice, injection of homologous lymphoid cells into foetal or newborn mice, affects them in such a way that when they grow up they are tolerant to skin grafts transplanted from the animal that provided the original inoculum, or an animal isogenic with it. When the antigenic relationship between donor and recipient is more distant it becomes more difficult to induce a state of tolerance. Wallace (1956) failed to establish tolerance to HeLa cells in rats. Using axillary metastases removed on two separate occasions from a patient with a malignant skin tumour I have failed to produce tolerance to this tumour in Wistar rats following intra-embryonic injection. Simonsen (1956), however, reported depression or delay of antibody formation by injecting human erythrocytes into chick embryos and newborn chicks.

Other methods

Combinations of cortisone and thorotrast have been used successfully (Takayama and Woolley, 1958) for growing H.Ep.3 (Toolan) in BALB-C strain mice. For the heterografting of animal tumours, Vasiliev (1958b) employed mouse sarcoma 180 in artificial air pouches in weanling rats. The tumour could be propagated serially by this method without cortisone treatment of the heterologous host. Vasiliev suggests that connective tissue proliferation around grafts of heterologous tumours can, in many cases, facilitate the establishment and enhance the growth of such grafts ; he also describes the stimulating effect on tumour grafts of living embryonic cells injected at the site of transplantation.

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The heterotransfer of cell-free material from human tumours has b en attempted on many occasions, particularly with the leukaemias and lymphomas. Bostick and Hanna (1955) claimed to have isolated an agent from Hodgkin's disease causing a diffuse encephalitis in mice. Storer and Lushbaugh (1949) found non-specific reactions in guinea-pigs, but no lymphocytic reaction in AK mice, after injecting extracts from livers and spleens of patients dying from various lymphomata.

A factor in the plasma of patients with chronic lymphatic leukaemia, lymphosarcoma and myelofibrosis, which is capable of inducing a lymphocytosis in baby mice has been described by Metcalf (1956). Cell-free filtrates from the brains of patients dying of acute leukaemia, when injected into AKR mice have accelerated the development of leukaemia (Schwarz, *et al.*, 1957), and leukaemia and occasionally haemorrhagic disease and multiple tumours have followed inoculation of cell-free extracts of human leukaemic tissues into newborn Swiss mice (Dmochowski, *et al.*, 1959).

Recently, Burnet (1959) drew attention to the importance of determining whether these agents play any significant part in the aetiology of human cancer. He believes that simple evidence from age incidence positively excluded a virus from aetiological consideration for all but one form of human malignancy—acute leukaemia.

HETEROTRANSPLANTATION OF NORMAL TISSUES

It has been shown (Greene, 1943) that embryonic tissues grow readily on heterologous transplantation to the eye or brain of untreated animals, and undergo differentiation without the inflammatory reaction that invariably attends the direct transfer of foreign adult tissues. In man, heterotransplantability is lost during the fifth month of gestation. Heterologous transplantation of embryonic skin to the subcutaneous space of the hamster and DBA mice also fails to elicit an inflammatory response. Greene (1955) found that takes were rare in the guinea-pig and rabbit but occurred with relative frequency in the hamster and DBA mouse. Toolan (1954b) has grown a variety of ten to sixteen weeks old human embryonic tissues including lung, skin, cartilage and intestine, in the cheek pouch of cortisone-treated hamsters, and subcutaneously in irradiated and cortisone-treated rats. Embryonic lung has been transferred for seven generations (100 days) in rats alone. Liver failed to survive or to grow. Human embryonic skin, cartilage and large intestine will also grow subcutaneously in cortisone-treated hamsters. Laznitski (1956) grew human embryonic lung *in vitro* for three to four weeks, then transplanted it to irradiated, cortisone-treated rats ; fifteen days after grafting, 80 per cent. of sixty-five implants had survived and grown well. Toolan (1951) has also found that adult skin and thyroid sometimes survive heterotransplantation and Hambrick and Bloomberg (1957) report that normal skin and basal cell carcinomas survive and proliferate in the cheek pouches of cortisone-treated hamsters.

My investigation into the transplantation of fragments of human embryonic lung into conditioned mice and hamsters was undertaken in the hope that this method might prove to be of use in testing carcinogenic substances directly on human tissues. A series of lung fragments has been
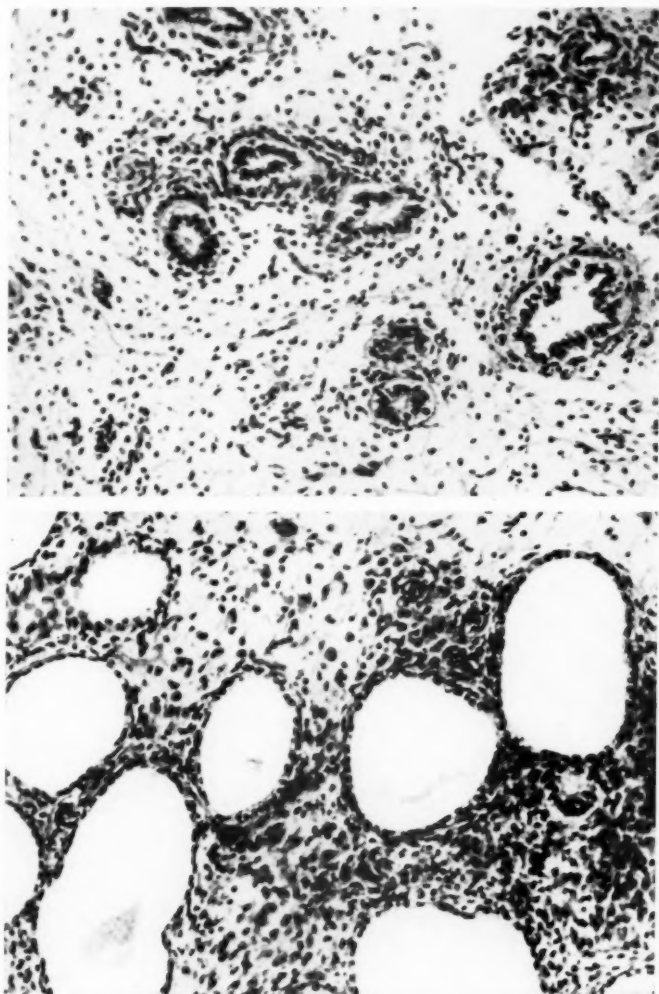

Fig. 4. Sections of lung from a thirteen-weeks-old human embryo. Upper picture —before transplantation. Lower—twenty days after subcutaneous transplantation to a cortisone acetate treated C57 mouse. Stained H. and E. × 200.

transplanted from sixteen human embryos, between the ninth and twen\`-
fourth weeks of gestation, to untreated and cortisone-treated C57 mi.e.
The embryos were obtained following spontaneous or therapeu.c
abortions. Some specimens were stored at +4 deg.C. before use. Fr: g-
ments of lung were implanted subcutaneously into adult C57 mice of
either sex using between ten and twenty mice for each embryo. The mice
received 2.5 mg. cortisone acetate at the time of implantation ; then
1.25 mg. bi-weekly, the dose being reduced if the animals showed toxic
effects. These experiments were carried out in collaboration with Dr.
L. M. Franks and he used adjacent portions of the embryonic lungs to
grow as organ cultures . It was soon found that prolonged survival of the
grafts did not take place in untreated animals but the histological appear-
ances of the grafts in treated animals are of interest. Comparison of the
appearances seen in a section of lung from a thirteen-weeks-old human
embryo before and after transplantation are illustrated in Figure 4. The
upper photomicrograph shows the lung before transplantation—a loose
stroma and primary bronchial branches with tall epithelium containing
subnuclear vacuoles. The lower picture shows the appearance of a graft
from this lung, at the same magnification, twenty days after transplan-
tation. The majority of the bronchial branches are dilated and the lining
epithelium is cubical or flattened. Whether this represents true differentia-
tion, similar to that described by Haemmerli (1958), or is a pathological
dilatation of existing bronchial branches, is difficult to assess by histo-
logical examination (Chesterman and Franks, 1959).

Less than one-fifth of the grafts survived for up to three weeks in
untreated mice but about one-half survived in mice treated with cortisone
acetate. About one-quarter survived for three to seven weeks in treated
mice, and only one in ninety-three untreated animals. The age of the
embryo did not appear to influence the survival period or the proportion
of successful transplants. Lung fragments from one fourteen weeks old
embryo were transplanted to the cheek pouches of six adult golden
hamsters initially treated with cortisone acetate. Portions of these
implants were examined after biopsy or autopsy. Histological examination
showed survival of parts of the grafts in five of the animals killed twenty-
five, thirty-four, sixty-nine and ninety-one days after transplantation. The
original tissue used for transplantation is shown at the top of Figure 5 ;
the appearances of a biopsy specimen sixty-nine days after transplantation
are shown in the lower part of the photomicrograph.

Attempts to transplant Wilms' embryonic renal tumours have not been
successful in my experience. Figure 6 shows the survival of the two types
of epithelia composing this " adenosarcoma " twenty-five days after sub-
cutaneous transplantation to a cortisone acetate treated hamster but no
progressive growth took place in any of the implants.

In summary, the transfer of human embryonic tissues to laboratory
animals may prove to be a useful method for testing the direct action of

chemical or physical agents on human tissues. The establishment of human tumours in laboratory animals is, in effect, a form of artificial metastasis, for example, from a patient with a cancer to the cheek pouch
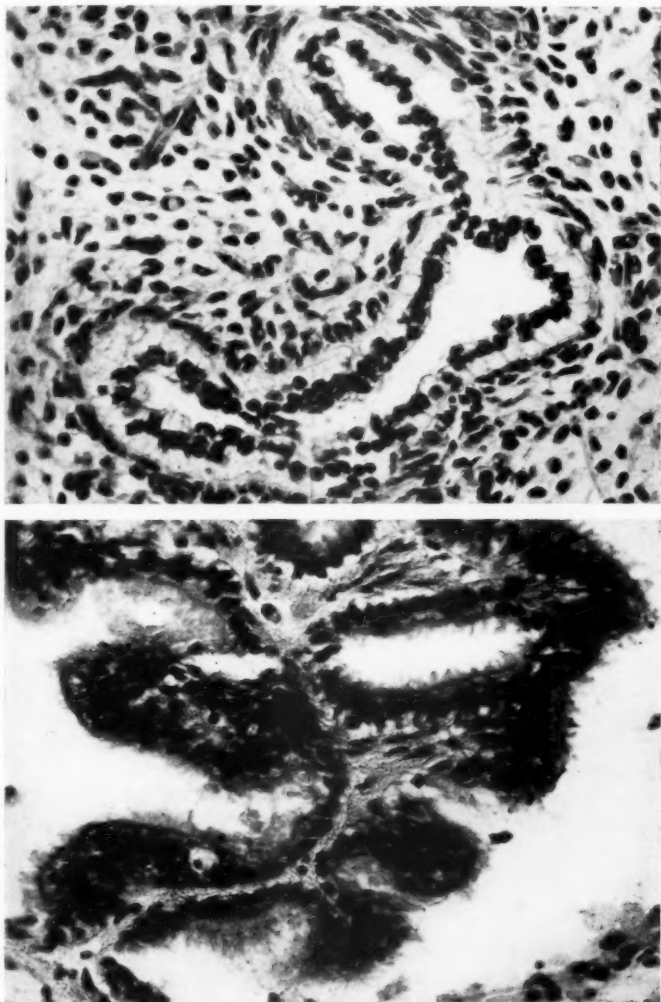
Fig. 5. Sections of lung from a fourteen-weeks-old human embryo. Upper picture—before transplantation. Lower—sixty-nine days after transplantation to a cortisone acetate treated hamster. Biopsy specimen. Stained H. and E.   ×440.

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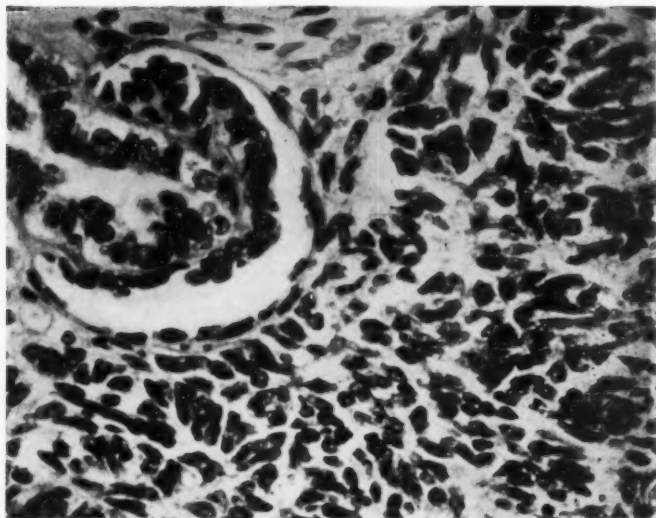
Fig. 6. Surviving epithelium of a Wilms' human tumour twenty-five days after subcutaneous transplantation in a cortisone acetate treated hamster. Stained H. and E. ×500.

of a hamster. In comparing the growth potentialities of human tumours in tissue culture and on heterologous transplantation to the eye and/or brain, Albrink and Wallace (1953) found no correlation between growth in tissue culture and growth on heterologous transplantation on the one hand, or the survival of the patient on the other. With a few exceptions the general histological appearances of the serially transplanted tumours have remained constant, resembling the original appearances in the human host.

Dobyns and Lennon (1952) described an undifferentiated thyroid tumour, arising in a fifty-six-year-old man, which was transplanted to the anterior chamber of the guinea-pig eye. Growths in the first generation of this tumour revealed a tendency towards differentiation ; as successive transplants of the tumour grew, a variety of histological patterns of carcinoma of the thyroid developed.

As human tumours are now being grown as transplantable tumours in laboratory animals it is important to know if they have changed their original characteristics. Iversen (1956) has reported an ascites tumour (H.A.1) which can be passaged in the peritoneal cavity of untreated mice. The tumour was originally taken from a woman, aged seventy-five, whose history is interesting in that she developed two tumours. In 1939 an adeno-carcinoma occurred in her right breast, with metastases to axillary lymph nodes, and a radical mastectomy was performed. In 1952, a solid

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carcinoma of the cervix (Stage III) was treated with X-irradiation and radium but the patient developed cachexia accompanied by increasing ascites which had to be drained every second week. Death occurred in 1955 and at autopsy metastases from a squamous cell carcinoma were found in the abdominal lymph nodes, peritoneum and peritoneal fat. Ascitic fluid recovered seven months before death was injected into the peritoneal cavities of ten mice treated with cortisone, and into ten control animals. Twenty-eight days later, three mice in the cortisone-treated group developed ascites, and on the fifty-second day a further mouse in the same group became ascitic. Fluid from two of these mice was passaged into further groups of mice. In the third passage, ascites occurred in the untreated controls and the average life-time of the animals was correspondingly shortened in both groups. After further mouse passages, chromosome studies revealed (Iversen, 1958) that the adapted ascites tumour contained cells with definite murine characteristics, whereas the cells before adaptation had human chromosome complements. Detailed studies on the effect of heterologous transplants on chromosomes of ascites tumours have been made by Ising (1958). The chromosome number of Ehrlich's ascites carcinoma decreased on heterotransplantation to hamsters and she concluded that the chromosomal changes were most likely the result of a selection of cells or of clones occuring in low frequency in the original lines.

Ouchterlony's agar-diffusion technique has been used to show that two human tumours, HS1 and H.Ep.3 still produce human tissue antigens after having grown for many generations in rats and hamsters treated with cortisone (Korngold and Lipari, 1955). Antisera against human tumours and tissues were also used to analyse the antigenic composition of approximately forty surgical specimens of normal and neoplastic tissues and five human tumours grown in conditioned rats and hamsters. It was found that of the four reference antigens studied, one occurred in all, and two in the majority of the surgical specimens, whereas a fourth was present in only half of the cases. All human tumours grown in foreign hosts lacked two or more of the reference antigens ; one tumour lacked three, and two tumours lacked all four. Korngold (1956) suggested that such tumours were deficient before transplantation or contained a few cells which were deficient and the latter were then biologically selected, or that growth in the foreign hosts resulted in the loss of these antigens.

Southam, Moore and Rhoads (1957a and b) found that suspensions of cells from some of the human tumours grown in culture or in animals regress if transplanted to normal adult human volunteers but take longer to regress, or may grow and metastasise, in debilitated cancer patients in the later stages of the disease when natural immunity is probably depressed and where serum properdin levels were known to be below normal. Grace (1958) has also shown that skin grafts transplanted to cancer patients persist for considerably longer than has been observed

with homografts to normal persons. Induced immunity has been demonstrated in normal volunteers and in cancer patients who have received a second inoculation of cancer cells (Southam and Moore, 1958). Tissue culture cells of human tumours transplanted into patients with advanced cancer have been used by Southam (1959) for the evaluation of anti-neoplastic agents, including viral oncolysis.

In his Imperial Cancer Research Fund Lecture Rhoads (1957) inferred that the neoplastic cell is the micro-organism of cancer, and that in one sense Koch's postulates have been fulfilled for human cancer by the isolation, cultivation and homotransplantation of human malignant cells.

Several workers have studied the metabolism (Balis, van Praag and Brown, 1956) and the effects of radiotherapy (Warren and Gates, 1957) on human tumours growing in conditioned animals. Others are developing methods to use human tumours in animals as a test system for the screening of anti-tumour agents (Toolan, 1958a). Relatively few human tumours have so far proved to be readily transplantable to laboratory animals and it has been suggested (Patterson, Chute and Sommers, 1954) that we can compare ourselves to the early bacteriologists who could grow only the hardiest bacteria.

There is one essential factor in the study of these new techniques for the investigation of human tumours under laboratory conditions, namely, the closest possible cooperation of the patient, the clinician, and the experimental pathologist.

ACKNOWLEDGMENTS

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THE IMPERIAL CANCER RESEARCH FUND

THE IMPERIAL CANCER Research Fund was established in 1902 under the direction of the Royal College of Physicians of London and the Royal College of Surgeons of England.

The work began in two small rooms provided by the Royal Colleges and was at first concerned with the compilation of a detailed analysis of cancer records since it was discovered that such statistics and information as were available were entirely inadequate and open to ambiguous interpretation. There followed investigations into problems connected with the incidence of cancer amongst different races of mankind and in different species of animals. During the years up to 1908, when the first stage of the work was completed, it had been demonstrated that cancer is not confined to man and that the disease is not, strictly speaking, an infective process but that a variety of causes can initiate and maintain the undisciplined and malignant growth of previously normal body cells that we know as " cancer."

From these preliminary researches the activities of the Fund expanded. Careful and prolonged investigations into the microscopic nature and the artificial growth of many different tumours formed a most important part of the early work, providing not only knowledge and methods necessary for progress but also material to enable others to take up cancer research in centres both in this country and abroad. A further development was concerned with the causation of tumours and this involved the study of numerous chemical and physical processes that take place in the living cell.

In 1939, the year in which the Fund was incorporated by Royal Charter, a block of laboratories was opened at Mill Hill, a site chosen to ensure close contact with the various departments of the Medical Research Council which were later to be established in that district. The Mill Hill Laboratories have been in continuous use since the day of opening and are, and must continue to be, the scene of invaluable fundamental research.

Modern developments

In 1951 the Council of the Fund resolved to extend its work by the study of certain special problems in human cancer and a vital branch of research which immediately aroused wide interest was begun in the Pathological Department of the Royal College of Surgeons by arrangement with the Council of that College. This work, known as " clinicopathological " research, marks a significant advance in the detailed study of particular human cancers. Fundamental research is largely concentrated on the basic problems of cancer as it affects all living creatures ; its origins, the interactions between host and tumour and the causes of progression towards increased malignancy. It is also concerned with the acquisition of biochemical knowledge that may lead in the future to effective growth control. Clinico-pathological research on the other hand sets out to examine the " human soil " on which the malignant growth

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occurs, that is, to investigate the patient by every means available using the skill of the physicist, the biochemist, the biologist and the pathologist in the closest co-operation with the physicians and surgeons of one or more of the great hospitals.

Plans for the future

The conditions first chosen were cancers of the breast and of the prostate and the development of this work made necessary the opening in 1953 of new laboratories at No. 48, Lincoln's Inn Fields. It is an urgent necessity that this most important branch of research should be broadened to include other forms of human cancer, particularly cancer of the lung. The present laboratory accommodation cannot be further increased and for this reason the Governors and Council of the Fund decided to build in Lincoln's Inn Fields new and adequate laboratories adjoining the Royal College of Surgeons of England. Plans have been approved and demolition has already begun. Thus there will be established in the heart of

Photograph showing the demolition of numbers 44, 45 & 46 Lincoln's Inn Fields in preparation for the erection of the new Imperial Cancer Research Fund laboratories.

London, the great capital of a country whose genius in medicine has given so much to the world, a centre where there will be brought together all the knowledge, experience and skill gained through many years, and where the facilities and equipment essential to the modern needs of research will be available. At these new laboratories centrally situated among the great hospitals and injuxtaposition to the research departments

of the Royal College of Surgeons, there will be investigations on cancer as it appears in the human patient. This approach may well be the means by which vital knowledge directly applicable to the treatment of the patient may be forthcoming and afford most valuable information to surgeons and others actively engaged in combating this disease.

The undertaking is a formidable one. The initial building costs are estimated to be at least £985,000 and about £250,000 will be required for furnishing and equipping the laboratories. Allowing for additional costs which will inevitably arise a capital sum of well over one million pounds must be regarded as necessary. Only the provision of this capital will make it possible to expand the range of the laboratory researches as to make use of the rapid advances of scientific method. For the maintenance of such progressive researches, to spend at least an additional £150,000 annually will be necessary.

The new research laboratories will provide accommodation for the clinico-pathological research work at present being carried out at No. 48, Lincoln's Inn Fields, but they will also make possible a big expansion in the research programme of the Fund.
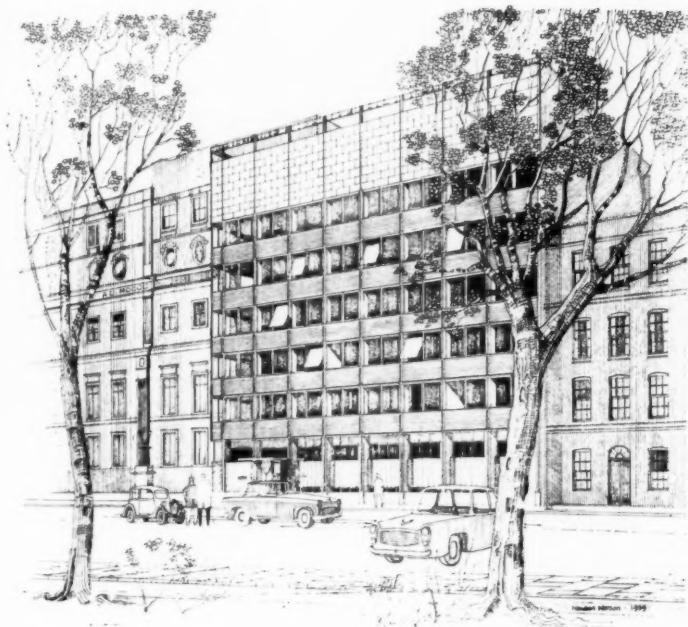
Ink sketch of the proposed elevation of the new laboratories in Lincoln's Inn Fields.

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The laboratories are being designed in such a way as to accommoda e many new developments in scientific apparatus which are essential for an adequate and incisive attack on the cancer problem. The situation of the se laboratories in Central London ensures that the staff will be able to wo k in close collaboration with their colleagues in the great hospitals.

IMPERIAL CANCER RESEARCH FUND
ANNUAL GENERAL MEETING, 1959

THE TWENTIETH ANNUAL General Meeting was held at the Royal College of Surgeons on Wednesday 22nd April 1959 when, in the unavoidable absence of the President, the Chairman of the Council, Sir Cecil Wakeley, Bt., took the Chair.

Sir Cecil said :

" My Lords, Ladies and Gentlemen, I know that you will share my regret that our President, Lord Halifax, who is taking a well deserved rest abroad, is unable to be with us. I know, too, that you will share my very great pleasure that Lord Halifax has very kindly consented to continue in office for another year, and we are most grateful to him for his very lively interest in the affairs of the Fund.

" The past year has been a significant one in that work in preparation for the building of the new laboratories has been well advanced and we look forward to the completion of the new building next year.

" In the Annual Report, which is in your possession, you will find not only a brief record of the research work of the past year but also an outline of the development planned for the future. I would ask you to regard your copy of the report as a proof to which some alterations and additions will be made.

"At the central laboratories, Mill Hill, Dr. Craigie, who has been the Director since 1949, has retired from this office but, happily, remains on the staff there to continue his research work. I would like to express the Fund's deep appreciation of all Dr. Craigie's labours.

" Dr. R. J. C. Harris has become head of the central laboratories and these laboratories now constitute a division of experimental biology and virology. To use Dr. Harris's own words, the aim of his work will be ' To explore further the virus aetiology of cancer with particular reference to the ways in which viruses gain access to the cells which they infect, their mode of replication in the cells and their specificity.' This is a vast field of research and one which promises to yield information of very considerable value.

"At the clinico-pathological laboratories at Lincoln's Inn Fields, Professor Hadfield has continued the invaluable work he has been doing since the laboratories were opened by him in 1953. The study of hormone dependent cancers has already produced significant results and this particular branch of research will be greatly expanded in the new laboratories. The importance of early detection of cancer cannot be over-emphasized, and not the least valuable part of the work that is being done in our clinico-pathological laboratories is concerned with this problem. As you will read in Professor Hadfield's report, some methods of early detection have already been established and a great deal of progress in this branch of research can confidently be expected.

" Professor Hadfield will retire from his post later this year and we shall deeply regret the loss of one who initiated a vital branch of research and who has made considerable contributions to our knowledge of cancer.

" In October, Professor G. F. Marrian will take up his duties as the Director of the Fund's laboratories and under him, as you will see from the foreword he has contributed to the Annual Report, the laboratories will be organized into a number of divisions, each in charge of a senior scientist.

" I have referred to some of the staff changes which will be taking place this year in our laboratories and I must now mention a matter of considerable importance affecting administration.

" Since the Fund was founded in 1902, and apart from a short interregnum, our affairs have been in the hands of only two Secretaries, and for more than twenty years Mr. Kennedy Cassels, the Secretary of the Royal College of Surgeons, has given his services to the Fund. It would be difficult for me adequately to express the Fund's indebtedness to Mr. Cassels who, with great skill and wisdom, has guided us through a period marked by a considerable expansion of our activities and which has included the difficult war years. Mr. Cassels feels that the time has come when he must be relieved of the great amount of work that the Secretaryship of the Fund now entails, a task which will bring even greater responsibilities when the new laboratories have been completed. The Council is, therefore, considering the appointment of a Secretary and I have no doubt that the right man will be found for this extremely important post. Happily, the new Secretary will have the benefit of the advice of Mr. Cassels, to whom I would express our most profound gratitude for his unremitting care of the Fund's affairs for so many years.

Sir Cecil Wakeley, Bt., presenting Miss Julie Andrews with her Life Governor's Certificate, with Sir Harry Platt, Bt., on the left of the picture.

" You will hear from our Honorary Treasurer that the Fund's finances are in a satisfactory state and it may be of interest to you if I give you some figures which indicate the growth of the support the Fund has received during the past six years. Contributions which in 1932-33 amounted to £19,137 amounted last year to £115,562, while the number of subscribers during the same period increased from 2,350 to 13,275 and to that figure should be added about 9,000 subscribers to the broadcast appeal. It will be appreciated, therefore, that a great deal has been done, but I must remind you that the maintenance of the new laboratories will mean additional annual expenditure of at least a quarter of a million pounds, and I am confident that none of you will fail to appreciate what that means. Certainly we shall need much wider support to enable us to meet the cost of the immense task confronting us. I believe that the necessary money will be forthcoming as the public become increasingly aware of the fact that donations are not frittered away in administrative expenses but provide the means for actual research work undertaken by men and women of the highest qualifications and under the directions of some of the foremost scientists, physicians and surgeons in the world.

" We have but one objective. To find, as quickly as possible, the cause and cure of a scourge which more than any other brings sorrow and suffering to every home. The answer to the cancer problem must be found. That it will be found is the faith in which we go forward."

Sir Cecil presented Life Governor Certificates to Miss Julie Andrews, Mrs. Jack Buchanan, Miss Anna Zinkeisen, Mr. Stephen Mitchell and Mr. Joe Davis.

PROCEEDINGS OF THE COUNCIL IN JUNE

AT AN ORDINARY Meeting of the Council on 11th June 1959, with Professor Sir James Paterson Ross, President, in the Chair, the Lady Cade Medal was presented to Squadron Leader T. C. D. Whiteside. The Hallett Prize was presented to Dr. D. F. Weinman of Ceylon. A resolution of condolence was passed on the death of Dr. Bernard Johnson.

The following were co-opted to the Council for the year 1958-59, representing various branches of practice :

General Practice—Dr. John H. Hunt
Anaesthetics—Dr. G. S. W. Organe
Ophthalmology—Mr. T. Keith Lyle, C.B.E.
Gynaecology and Obstetrics—Mr. A. C. H. Bell
Radiology—Professor D. W. Smithers
Otolaryngology—Mr. C. Gill-Carey
Dental Surgery—Sir Wilfred Fish, C.B.E.

Examiners for the year 1959-60 were elected.

The following were elected to the Fellowship in the Faculty of Dental Surgery : Mr. W. E. Earle (U.K.), Dr. Don Gullett (Canada), Professor K. Sutherland (Australia) and Dr. P. H. Jeserich (U.S.A.).

One diploma of Membership was granted.

The award of the Gilbert Blane Medal for 1959 to Surgeon Commander J. Glass was approved.

The following hospitals were recognised under paragraph 23 of the Fellowship regulations.

HOSPITALS	POSTS RECOGNISED		
	General (6 mths. unless otherwise stated)	Casualty (all 6 mths.)	Unspecified (all 6 mths.)
WAKEFIELD — Clayton Hospital (additional)	*Recognition withdrawn from* 3rd H.S.	J.H.M.O.	
CHEAM—St. Anthony's Hospital (additional)	*Confirmation of temporary recognition* Surgical Registrar Senior H.S. Junior H.S.		
ST. ALBANS — City Hospital (additional)	Pre-reg. H.S.		
LONDON—South Western Hospital	Recognition to be transferable between the posts of H.S. and S.H.O. (Gen. Surg.)		
CROYDON—General Hospital (re-designation)	*Redesignation of* Senior Surgical Regr. *as* Surgical Registrar (6 mths.) (Reduction in period of recognition of existing Registrar from 12 to 6 months)		
LONDON — St. Giles Hospital (additional)			Orth. H.S.
CROYDON—Eye Unit			*Under para.* 23 (*b*) Ophth. H.S.
SOUTHAMPTON — Royal South Hants Hospital (additional)		2 Cas. Offs.	2 Orth. Regrs.
BEBINGTON—Clatterbridge General Hospital (additional)		*Transfer of recognition of* J.H.M.O. to 2 S.H.O. posts	
HALIFAX—Royal Infirmary (additional)		S.H.O.(Cas.)	S.H.O.(Orth.)
BRIGHTON—Royal Sussex County Hospital (additional)		Senior Cas. Off. (J.H.M.O.)	
LONDON—Royal Homoeopathic Hospital (additional)	Senior H.S.		
STOCKPORT—Stepping Hill Hospital (additional)	Pre-reg. H.S.		
BOLTON & District General Hospital (redesignation)	*Redesignation of* S.H.O. as Regr.		
BOLTON—Royal Infirmary (redesignation)	*Redesignation of* S.H.O. as Regr.		

RECENT OVERSEAS VISITORS TO THE COLLEGE

RECENT OVERSEAS VISITORS to the College have included Dr. Paul Hawley, Director of the American College of Surgeons, who was admitted to the Honorary Fellowship of the College and Sir Henry Pierre of Trinidad, who was admitted to the Fellowship of the College after Twenty Years' Standing, at the Diploma-Granting Ceremony on June 10th: Dr. and Mrs. Gibbon of Philadelphia, Mr. E. D. Ahern of Welkom, and Dr. and Mrs. W. Kark of Johannesburg, all of whom attended the monthly dinner in May: Dr. Barry Anson of Chicago, who delivered a lecture in the College in May: and Mr. V. Da Silva of Bombay and Professor and Mrs. de Silva of Ceylon who attended the monthly dinner in June.

HONORARY FELLOWSHIPS

AT THE MEETING of Council in May, Mr. E. D. Ahern of Brisbane and Dr. John H. Gibbon of Philadelphia were admitted to the Honorary Fellowship.

Introducing Mr. Ahern, Professor Lambert Rogers spoke as follows :

" Mr. President and Members of Council, I have the honour and it gives me much pleasure to present Mr. E. D. Ahern of Brisbane for the Honorary Fellowship of our College.

" Mr. Ahern graduated in the University of Melbourne but left there to practise in Brisbane where he has become Senior Surgeon to the Mater Misericordiae Hospital and is much beloved by his patients and by his friends and colleagues, to whom he is affectionately known as Ted Ahern. Many of us who have visited Brisbane have experienced his charm and courtesy as a host.

" He was a founder member of the Royal Australasian College of Surgeons and one of the twelve members who formed the first Council to constitute the governing body of that distinguished College. In 1940 he was its Vice-President and the following year was elected President, being the first surgeon in Queensland to hold that high office.

" Colonel Ahern served with the Australian military forces in both world wars ; in the first with the 14th Australian General Hospital and the 1st Light Horse Field Ambulance and later as Consulting Surgeon to the 1st Australian Military District and in the more recent war with the 117th Australian General Hospital.

" While a general surgeon in the wide sense of the term, he has made a special study of, and contributed to, the surgery of the thyroid gland. He has served on

Mr. E. D. Ahern receiving his Diploma of Honorary Fellowship from the President, with Sir Archibald McIndoe, Vice-President, watching.

numerous committees and played an important part in the development of surgery in Queensland and of the Faculty of Medicine in its Medical School.

" Mr. President, I present to you, Edward Dennis Ahern, senior surgeon, soldier, sportsman, charming host, leader in his profession and past President of the Royal Australasian College of Surgeons, for the conferment at your hands of the Honorary Fellowship of this College."

Mr. Ahern thanked the Council for the great honour conferred on him and spoke of the friendship which had at all times existed between the Royal Colleges of Surgeons in England and Australasia, and the noteworthy help and advice which the English College had given in the early days of his own College in Melbourne.

Dr. John Gibbon, who was admitted to the Honorary Fellowship of the College, with Mrs. Gibbon.

Sir Russell Brock delivered the following citation in honour of Dr. Gibbon :

" Mr. President, Members of Council, it is a special privilege and honour for me to say something of the great contributions of Dr. John Heysham Gibbon which have earned him our esteem.

" Jack Gibbon, as he is called, was born in Philadelphia, the son of a distinguished surgeon, and has spent almost all his working surgical life in that city where he was appointed Professor of Surgery in 1946 at the Jefferson Medical College and Hospital. His many other appointments, commitments and activities are too numerous for me even to outline, but they indicate the high position he holds among the leaders of American surgery today.

" His name will always be associated with the introduction of the heart-lung machine which enables us to perform deliberate, unhurried operations under direct vision upon the open heart. Today this type of surgery is front page news ; its possibilities and achievements excite the imagination of everyone, lay and medical alike. This interest even extends behind the Iron Curtain and at this very moment a British team from the Postgraduate Hospital is performing successful operations using this technique in Moscow by invitation of the Soviet Academy of Medicine ; surely a happy event which if repeated in other fields might well help towards a better understanding between the East and the West. Successful closed operations upon the human heart, previously somewhat sporadic, became established as routine procedures some ten years ago. It is remarkable that it was in 1937, more than twenty years ago and when little was being thought of operations upon the open heart, that Jack Gibbon published his first article on his laboratory research on a heart-lung machine. This work was inevitably interrupted by the war, but when resumed it resulted in the publication of a steady stream of articles all presenting the basic physiological and other data essential for understanding the problems involved if successful heart-lung by-pass was to be achieved.

" When one reads back over the work of Gibbon at this time one is astonished and impressed with the wealth of basic information it contains. Nearly all we know today about pumps, the control of blood volume, of alterations in chemical and physical characters of the blood, the clotting mechanisms and oxygenation itself are due to his original researches. It was in 1951 that, after a trial of numerous other devices, he introduced the vertical screen oxygenator, a method still perhaps the most popular today, and could report a high survival rate in animals who had undergone total venacaval occlusion for twenty to thirty minutes. In 1952 he was able to report a 100 per cent. survival in twelve dogs in whom the circulation had been interrupted for sixty to 100 minutes and in four of these the right atrium had been opened for half to three-quarters of an hour, all four animals surviving.

"A great achievement, perhaps all the greater because the other research workers who were now crowding into the field were obtaining indifferent, confusing and disheartening results. Gibbon, however, wrote that it would not be long before this method of open heart surgery could be used safely on humans.

" His firm prophecy was fulfilled only one year later when, on 6th May, 1953, he became the first surgeon in the world to operate successfully on the human heart using a heart-lung machine. His patient was a girl of eighteen years in whom he exposed and sutured an atrial septal defect.

" It was exactly two years later, in May 1955, that Kirklin began to use on humans at the Mayo Clinic the elaboration of the original Gibbon machine, now known as the Mayo-Gibbon model. All the world knows the rest of the story. The Mayo Clinic using this type of apparatus born of Dr. Gibbon's researches has achieved world-wide fame in heart surgery. Numerous other types of heart-lung machines are used in clinics and hospitals in many countries throughout the world.

"All this has sprung from Jack Gibbon's work begun over twenty years ago, carried on through what must have been years of difficulties, disappointments and frustration, and yet brought to triumphant success. It is for these reasons, Mr. President, that I think that the occasions have been very few on which an Honorary Fellowship of this College has been more richly deserved and that this College will gain honour by adding Dr. John Heysham Gibbon's name to its already distinguished list of honorary fellows.

" Before you confer this Fellowship upon him I must reveal to you something that I have deliberately not mentioned so far. From the very beginning of his

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work right up until the time of its successful conclusion in 1953 Dr. Gibbon had the able and enthusiastic assistance in the laboratory of the lady whom he had married in 1931 ; we are very happy to have Mrs. Gibbon present today at this ceremony.

" Mr. President, it is with great pleasure that I ask you to confer upon Dr. J. H. Gibbon the Honorary Fellowship of this College."

Dr. Gibbon expressed himself as delighted and honoured at taking his place in a long line of American surgeons who had been awarded the Honorary Fellowship of this College—a line headed by the late W. W. Keen, also of Philadelphia, who was among the first recipients in 1900.

GRANT OF FELLOWSHIP DIPLOMAS

AT THE RECENT Final Examination for the Fellowship four candidates out of twenty were successful in Ophthalmology, seven candidates out of twenty-four in Otolaryngology, and ninety-seven out of 336 in General Surgery.

At an Extraordinary Meeting of the Council on 10th June 1959 Diplomas of Fellowship were granted to the following :

†THOMPSON, John Douglas (*King's Coll.*)
WOOLF, Anthony John (*St. Mary's*)
BROWN, Harold Spencer (*St. Bartholomew's*)
RIHAN, Robert Stanley (*Birmingham*)
*STARBUCK, Mary Joan (*King's College*)
CLARKE, David Barry (*Birmingham*)
ALLEN, Leonard Norman (*University College*)
CREE, Ian Campbell (*University College*)
MALTBY, John Wingate (*St. Bartholomew's*)
NGU, Victor Anomah (*St. Mary's*)
ROBINSON, Kingsley Peter (*Westminster*)
DALY, David William (*Leeds*)
ASHKEN, Michael Ralph Handley (*Middlesex*)
ATWELL, John David (*Leeds*)
PACKHAM, Derek Albert (*King's College*)
FOY, Idris Howard (*Liverpool*)
VAN GELDEREN, Philip William (*Sydney*)
AUSTIN, Richard Neville (*St. Bartholomew's*)
†STUART, David Wallington (*St. Mary's*)
*THORNHILL, Cecil William (*Irish Royal Colleges*)
*KAPUR, Satya Bhushan (*Punjab*)
BRUCE, Andrew Watt (*Aberdeen*)
†FAZLEABAS, Turabally (*Ceylon*)
THAMBUGALA, Ranjitsingha Lakshman (*Ceylon*)
COURT, Geoffrey Alden (*St. Bartholomew's*)
LEITCH, Ian Harding (*Witwatersrand*)
MEHTA, Mini Hoshang (*Calcutta*)
NABAR, Bhalchandra Vasudeo (*Bombay*)
RACK, Peter Michael Horsman (*The London*)
HEATH, Edgar Thomas (*Leeds*)
JANSZ, Aubrey William (*Ceylon*)
JAYAWARDENA, Philip Michael (*Ceylon*)
LEITCH, David Stanley (*Sydney*)
MAGELL, Jack (*Wales*)
TOWNSEND, Arthur Carlisle (*Middlesex*)

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CRABBE, William Anthony (*Durham*)
HOPE, Bertram Kendall (*Sydney*)
OVENDALE, Charles Owen (*Witwatersrand*)
SOLOMON, Louis (*Cape Town*)
SYMON, Lindsay (*Aberdeen*)
THOMAS, Thomas Glyn (*Guy's*)
VAITHILINGAM, Puspanathan Sadasivan (*Scottish Royal Colleges*)
WEARNE, William Maxwell (*New Zealand*)
ANDERSON, John (*St. Andrews*)
BENJAMIN, Victor Ariyaratnam (*Ceylon*)
COOKE, Reginald Ratnaraja (*Ceylon*)
HARTLEY, Richard Cedric (*Birmingham*)
HITCHCOCK, Edward Robert (*Birmingham*)
KOHORN, Ernest Ignatius (*University College*)
LITTLE, Elsa (*Durham*)
LOOKMAN, Abbas Ahmedally (*Bombay*)
MADIGAN, Michael Roebourne (*Adelaide*)
MANDELL, Barend Bernard (*Witwatersrand*)
MILLAR, David Gavin (*Durham*)
MOVSAS, Samuel (*Witwatersrand*)
O'ROURKE, Desmond Anthony (*Queensland*)
RAJAGOPALAN, Susila (*Madras*)
SELLWOOD, Ronald Arthur (*Bristol*)
SHAH, Vasantlal Gulabchand (*Bombay*)
TURNER, Leslie (*Manchester*)
UPADHYAYA, Purushottam (*Agra*)
WILLIAMS, William Gilbert (*Bristol*)
ALDRIDGE, Richard Thomas (*New Zealand*)
BHONSLA, Braj Nandan Singh (*Patna*)
BREMNER, John Cameron (*Melbourne*)
COLLIBEE, John Mervyn (*Sydney*)
*COOTE, Barry Desmond (*Sydney*)
CUTHBERTSON, Alan Morton (*Melbourne*)
DHARAM RAI (*Osmania*)
†FINNEY, Dallas (*Sydney*)
GHOSH, Ajit Kumar (*Calcutta*)
KUMAR, Raj (*Punjab*)
LECKIE, Donald Norman (*Sydney*)
LEWIS, Ernest (*Witwatersrand*)
MACBETH, William Andrew (*Adelaide*)
MACNEIL, Peter Robin (*Melbourne*)
MILL, James Crowe Davidson (*Adelaide*)
MURTHY, Subbarayan Keshava (*Mysore*)
OATES, Geoffrey Donald (*Birmingham*)
ROBERTS, Edmond Graham (*Melbourne*)
SIEGENBERG, Joe (*Witwatersrand*)
SINCLAIR, Geoffrey William Gladstone (*Melbourne*)
†SMYTH, Gordon Dill Long (*Belfast*)
VICKERY, Christopher Michael (*St. Bartholomew's*)
WONG, Soon Kai (*Malaya*)
ARORA, Uday Shankar (*Calcutta*)
CHAN, Kong Thoe (*Malaya*)
CHIRNSIDE, Alan Maxwell (*New Zealand*)
FOX, Bruce Walter (*Melbourne*)
GOKAVI, Walter Alfred (*Madras*)
HEALEY, Raymond Joseph (*Sydney*)
HOOKER, Colin Holloway (*New Zealand*)

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IU, Po Yat (*Hong Kong*)
KILLINGBACK, Marcus James (*Sydney*)
†LUND, William Spencer (*Guy's*)
MOULTON, John Egan (*Sydney*)
SHRIKHANDE, Vinayak Nagesh (*Bombay*)
STEEDMAN, Paul Keith (*Melbourne*)
STEIN, David (*Cape Town*)
AL-KHAYAL, Walid Schowkat (*Baghdad*)
COUR-PALAIS, Ian James (*Westminster*)
HUGHES, Peter Dalton (*Sydney*)
SHANAHAN, Mark Xavier (*Sydney*)
TAYLOR, Thomas Kinman Fardon (*Sydney*)
WALD, Marx (*Sydney*)
YEOH, Kean Seng (*Sydney*)

and at the Quarterly meeting of the Council in July to :

BREMNER, Cedric (*Witwatersrand*)
†GRAY, George Lionel (*Queensland*)
*In Ophthalmology.   †In Otolaryngology.

DONATIONS

DURING THE LAST few weeks the following generous donations have beeu received :

£7,500		Corporation and Members of Lloyds and Lloyds Brokers.
£3,571	8s. 6d.	Shell International Petroleum Co. Ltd. (first of seven annual contributions).
£1,500		Smiths Charity, Kensington Estate.
£1,000		S. G. Menell, Esq.
		Imperial Tobacco Co. Ltd.
		Norwich Union Life Assurance Society Ltd.
		Smith Kline & French Laboratories, Ltd.
£525		British Electric Traction Ltd.
£500		Amalgamated Dental Co. Ltd.
£350		Royal Insurance Co. Ltd. (first of seven annual contributions)
£300		Coutts & Co.
£262	10s. 0d.	*The Practitioner*
		Refuge Assurance Co. Ltd.
£250		Phoenix Assurance Co. Ltd.
		Midland Bank Ltd. (first of seven annual contributions).
		J. Bibby & Sons, Ltd. (first of seven annual contributions).
		Portals Ltd.
		Rhodesian Selection Trust Ltd.
		R. M. Burton, Esq.

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£250	R. Silcock & Sons, Ltd. (first of seven annual contributions).
	Whitehall Securities Corporation, Ltd.
£210	Maple & Co. Ltd.
£200	Alex Quig, Esq.
£150	Mond Nickel Co. Ltd. and Henry Wiggin & Co. Ltd.
	Wiggins Teape & Co. Ltd. (first of seven annual contributions).
£105	United Glass, Ltd.
	Securities Agency, Ltd.
	Woodfords (Leicester) Ltd.
	Sayers (Confectioners) Ltd.
	Blundell Spence & Co. Ltd.
	R. A. Lister & Co. Ltd.
	Butterworth & Co. Ltd.
	Lambert Bros., Ltd.
	Alfred Bird & Sons, Ltd.
	Consolidated Tin Smelters, Ltd.
	T.W.W. Ltd. (I.T.V. for S. Wales and West of England).
	Crosse & Blackwell (Holdings) Ltd.
	Kennings, Ltd.
	R. Rowley & Co. Ltd.
	Thomas Hedley & Co. Ltd.
	Regis Property Co. Ltd.
	Ilford Ltd.
	Angus Fraser, Esq.
	Peglers, Ltd.
	Canada Life Assurance Co.
	British Rollmakers Corporation Charitable Trust.
	Arthur Lee & Sons, Ltd.
	Singer and Friedlander, Ltd.
	Evans Medical Supplies Ltd.
£100	Midland Counties Dairy, Ltd.
	Edward Webb & Sons (Stourbridge) Ltd.
	Young & Co.'s Brewery, Ltd.
	E. S. & A. Robinson, Ltd. (first of ten annual contributions).
	The Silver Line, Ltd.
	British Bank of the Middle East.
	H. B. Chrimes, Esq.
	H. & R. Johnson, Ltd.
	Wm. Proctor Smith, Esq.
	Wolsey, Ltd.
	The Consolidated Zinc Corporation, Ltd. (first of seven annual contributions).

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£100	Savory & Moore, Ltd. (first of seven annual contributions).
	Mrs. Sydney MacDonald.
	Mrs. J. G. Weir.
	Peter Walker (Warrington) Ltd.
	Standard Bank of South Africa., Ltd.
	W. E. Dunn Charitable Trust.
	Seccombe, Marshall & Campion, Ltd.
	Esso Petroleum Co. (Medical Dept.) (further gift).
	J. A. Jenkins, Esq., F.R.C.S.
	Broken Hill South, Ltd.
£81 12s. 8d.	The Sea Insurance Co. Ltd. (first of seven annual contributions).
£75	Tharsis Sulphur and Copper Co. Ltd.
£52 10s. 0d.	Liverpool Stock Exchange.
	Hongkong & Shanghai Banking Corporation.
	Ward & Goldstone, Ltd.
	National & Grindlays Bank Ltd.
	Oral Surgery Club.
	Rediffusion, Ltd.
	Wm. Roberts, Esq.
	Bass, Ratcliffe & Gratton, Ltd.
	British Pepper & Spice Co. Ltd.
	J. W. Cameron & Co. Ltd.
	Heenan Group Ltd.
	Thomas Merry Charitable Trust.
	R. Raphael & Sons.
£50	Metal Industries, Ltd.
	The Birkenhead Brewery Co. Ltd.
	National Bank of New Zealand.
	Martins Bank, Ltd.
	Sir Clement Price Thomas, K.C.V.O., F.R.C.S.
	Higsons Brewery, Ltd.
	The Permutit Co. Ltd.
	Gillett Bros. Discount Co. Ltd.
	District Bank, Ltd.
	Westland Aircraft, Ltd.
	The National Bank, Ltd.
	Horseley Bridge & Thos. Piggott, Ltd.
£25	Wm. Crawford & Sons, Ltd. (first of six annual contributions).
	Mr. and Mrs. F. D. Sharples (first of six annual contributions).

Donations towards the cost of furnishing the new Committee Rooms:

| £150 | Association of Surgeons of Great Britain & Ireland. |

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£75	Regional Hospital Consultants and Specialists Association.

Appeal covenants:

£14,285 14s. 3d. p.a. for 7 years	Harold Samuel, Esq.
£2,143 p.a. for 7 years	British Petroleum Co. Ltd.
£1,000 p.a. for 7 years	Turner & Newall, Ltd.
£500 p.a. for 7 years	Guest, Keen & Nettlefolds Group Services, Ltd.
£357 3s. 0d. p.a. for 7 years	International Computers & Tabulators, Ltd.
£300 p.a. for 7 years	Legal & General Assurance Co. Ltd. Joshua Tetley & Son, Ltd.
£250 p.a. for 10 years	Commercial Union Assurance Co. Ltd. Alliance Assurance Co. Ltd.
£250 p.a. for 7 years	Barclays Bank, Ltd. Lloyds Bank, Ltd. Westminster Bank, Ltd.
£214 6s. 0d. p.a. for 7 years	National Provincial Bank, Ltd. (second covenant).
£200 p.a. for 7 years	N. British & Mercantile Insurance Co. Ltd. Birmid Industries, Ltd. London Assurance.
£150 p.a. for 7 years	Birmingham Post & Mail, Ltd. Atlas Assurance Co. Ltd. Sun Life Assurance Society. Dorman, Long & Co. Ltd.
£143 p.a. for 7 years	Cammell Laird & Co. Ltd.
£142 17s. 2d. p.a. for 7 years	Woolcombers, Ltd.
£105 p.a. for 7 years	David Bridge & Co. Ltd. National Farmers Union Mutual Insurance Society.
£100 p.a. for 10 years	Whitbread & Co. Ltd. Union Discount Co. of London, Ltd.
£100 p.a. for 7 years	British Drug Houses, Ltd. Associated British Picture Corporation, Ltd. Guardian Assurance Co. Ltd. Liebigs Extract of Meat Co. Ltd. Massey-Ferguson Holdings, Ltd. Metropolitan Estate & Property Corporation, Ltd. Ind Coope, Ltd.

£100 p.a. for 7 years	Albert E. Reed & Co. Ltd. Waterworth Bros. Ltd. Sun Insurance Office, Ltd. Relay Exchanges, Ltd.
£52 10s. 0d. p.a. for 7 years	National Mutual Life Assurance Society.
£50 p.a. for 7 years	C. C. Wakefield & Co. Ltd. Clifford Motor Components, Ltd. John Mackintosh & Sons, Ltd. Bovril, Ltd. Mercantile & General Reinsurance Co. Glyn Mills & Co. Imperial Typewriters Co. Ltd. Colonial Mutual Life Assurance.
£25 p.a. for 7 years	Associated Paper Mills, Ltd. C. T. Bowring & Co. Ltd. C. T. Bowring & Co. (Insurance) Ltd.
£20 p.a. for 7 years	Rockware Glass Ltd.
£16 6s. 6d. p.a. for 7 years	Cuxson, Gerrard & Co. Ltd.
£10 10s. 0d. p.a. for 7 years	Gabriel, Wade & English Ltd. Sidney Flavel & Co. Ltd.
£10 p.a. for 7 years	Jessel, Toynbee & Co. Ltd.

THE FELLOWS' COMMON ROOM

THE COUNCIL HAS now made available for Fellows a Common Room on the ground floor of the College. This is a pleasant room with panelled walls, facing South and comfortably furnished, and it is available for use at all times when the College generally is open.

The room is a memorial to Sir John Bland-Sutton, who was President in 1923-1926 and subsequently (through his Will and that of his widow) a great benefactor of the College. Bland-Sutton's portrait, by the Hon. John Collier, and certain of his possessions provide some of the furniture and embellishments of the room.

The Bland-Sutton Room also provides a retiring room for the Court of Examiners when examinations are in progress in the College and it is the starting point from which the President and Council walk in procession on ceremonial occasions.

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GUILDFORD CATHEDRAL

WE HAVE BEEN asked to remind readers that funds are still urgently required for the *Doctors' Window* in Guildford Cathedral.

The two panes of the Window contain stained glass depicting St. Luke and Moses raising the serpent of brass. In addition one will have the Coat of Arms of the British Medical Association, and the other that of the Society of Apothecaries.

So far £944 towards the total of £1,400 has been raised. Further donations will be gratefully received by the Treasurer of the Appeal, Dr. F. A. Belam, 1, Westfield, Epsom Road, Guildford, Surrey, and should be made payable to " The Doctors' Cathedral Window Fund."

DIARY FOR SEPTEMBER

Wed.	2		College closed.
			Primary F.D.S. Examinations begin.
Mon.	7		Basic Sciences Lectures and Demonstrations begin.
Wed.	9		Second L.D.S. Examination begins.
Wed.	16		D.C.H. Examination begins.
Thur.	17		Pre-Medical Examination begins.
Wed.	23		D.Orth. Examination begins.
Thur.	24		First Membership Examination begins.
		5.00	DR. J. B. ENTICKUP—Erasmus Wilson Demonstration.*
Fri.	25	5.00	Board of Faculty of Dental Surgery.
Mon.	28		Surgical Lectures and Clinical Conferences begin.
Thur.	29		Final Membership Examination begins.

DIARY FOR OCTOBER

Wed.	7	5.00	PROFESSOR R. G. ROBINSON—Hunterian Lecture—Hydatid disease affecting the nervous system.*
Thur.	8	2.00	Quarterly Council.
		5.00	MR. L. C. NORBURY—Gordon-Watson Lecture.*
Mon.	12		Anaesthetic Course begins.
Wed.	14		Final L.D.S. Examination (Part I) begins.
			D.M.R.D. Examination (Part I) begins.
			D.M.R.T. Examination (Part I) begins.
		5.00	Board of Faculty of Anaesthetists.
Fri.	16		Course in Clinical Surgery and Surgical Lectures and Clinical Conferences end.
Tues.	20		Final Fellowship Examination (Ophthalmology and Otolaryngology) begins.
Wed.	21		Final L.D.S. Examination (Part II) begins.
			D.M.R.D. Examination (Part II) begins.
Thur.	22	4.15	DR. S. ENGELL—Arnott Demonstration.*
Fri.	23		Anaesthetic Course ends.
Tues.	27	5.00	DR. K. M. BACKHOUSE—Arris and Gale Lecture.*
Wed.	28		Primary F.R.C.S. Examination begins.
			D.M.R.T. Examination (Part II) begins.
		5.00	MR. D. GREER WALKER—Arnott Demonstration.*
Thur.	29		D.Path. Examination begins.
		5.00	MR. H. R. THOMPSON—Thomas Vicary Lecture.*

*Not part of the courses.

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VISUAL PIGMENTS IN THE LIVING EYE

Dr. W. A. H. Rushton, F.R.S., Sc.D., M.R.C.S.

Physiological Laboratory, Cambridge

THE HONOUR WHICH this famous College confers upon those whom it invites to give its public lectures stands, perhaps, in an inverse relation to their distinction in surgery. In that case I must be one of the most honoured of all your lecturers, to judge by the effort and time it took me to climb the first lowly step to your membership—an effort which exhausted my entire talent in the surgical art. Thus I am the more sensible of the distinction you have bestowed in inviting me to give the second Edridge Green Lecture.

A study of the history of colour vision gives reasonable ground for the view that colour is appreciated in the lateral geniculate body and not in the cerebral cortex. For the protagonists of various theories exhibit the high emotional response coupled with lack of critical discrimination which characterizes the thalamic syndrome. And this must particularly have been the situation in the early years of this century when the famous Helmholtz-Hering controversy had reached a very sterile phase.

Edridge Green, at any rate, would have none of it and, rejecting almost entirely the approach through the measurement of physical stimuli, he developed a very original theory based largely upon entoptic effects and the classification of perceptions in so far as these could be expressed in words.

This is somewhat treacherous ground upon which to build sound theory, for entoptic effects are often hard to observe and difficult to analyse, and words have serious limitations in the finer descriptions of colour, especially where the speaker has abnormal vision. So the verdict of posterity may well be that Edridge Green's chief contribution to colour vision and to society lay in making the public conscious of the commonness of colour defects in males, and the importance of having really satisfactory tests with which to examine those who need to use coloured signals.

The approach to colour vision which I wish to place before you to-day is just the reverse of Edridge Green's. It starts, not from the nature of our perceptions, but from the nature of light itself. It is therefore upon a very sound foundation.

That at least is the view I wish you to take, so I must be careful to say very little about the quantum theory or the way in which light manages to be both an undulation with precise wave-length and at the same time an atom of energy of precise magnitude. It is physically respectable however to say that while light is flying through space it is in the form of waves in which the energy is conserved. Such light cannot be seen

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since only by giving up some of its energy can light *do* anything, and light must react with the eye in order to excite it. But in its reaction with matter light behaves as a shoal of atoms of energy—the quanta—so the *retina* is well named, it is a net which trawls the aether for quanta, and notes the time, place and the nature of the catch.

If we trawl in seas where fish are scarce we won't catch much in a small net, and even the large net had better be left down for some time before pulling in the catch. In this way we shall get some yield but we shall not know at all precisely when or where the fish were caught. Similarly the eye, adapted to darkness where quanta are scarce, spreads wide its receptive fields so the *summation area* is increased, and so also is the *summation time*, but what we gain in sensitivity we lose in resolution ; acuity is poor and flicker-fusion is slow.

What are the meshes of the net in which the fish get entangled, what is the material in the eye which catches the quanta ? Anything which absorbs light does so by catching its quanta, and such a substance is called a pigment. The sort of pigments we naturally think of are those used to colour things, such as paints and dyes, but such are precisely the wrong kind to be the starting point of vision. For our dyes must be " fast, " the curtains must not fade in the sunlight, so the light quanta
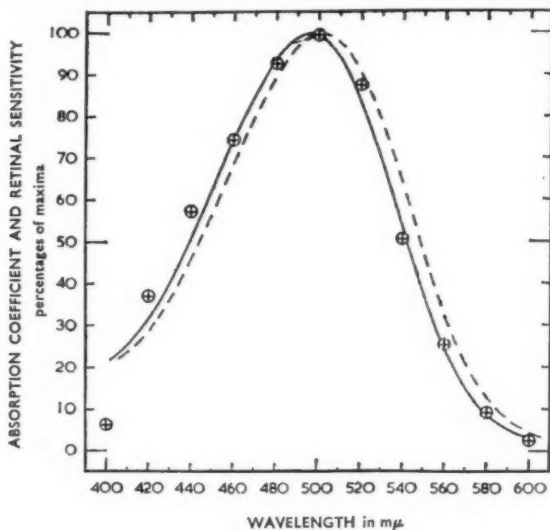

Fig. 2. Comparison of the human retinal scotopic sensitivities (⊕), with the absorption spectra of visual pigment 497 from man (———) and visual pigment 502 from the frog (– – –)

Fig. 1. Full curve, absorption spectrum of human rhodopsin : circles, corrected twilight spectral sensitivity. (From Crescitelli, F., and Dartnall, H. J. A., 1953, *Nature, Lond.* **172,** 195.)

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must be caught and degraded into heat without any chemical change of the pigment. But light so utterly degraded is useless as the starting point of vision. We need a pigment the reverse of " fast," one which is photo-sensitive, which upon absorbing a quantum will undergo a chemical transformation. There are people who on hearing music are unaffected, there are some who respond by vibration of foot or finger, but some there are who rise and dance and change partners. Such a dance of atoms was seen in 1876 when Boll first described the bleaching of visual purple in the frog's retina which had been excised in dim light and was then observed in full daylight.

It was realized at once that visual purple (or rhodopsin) was a chemical by which the eye could catch quanta and use the catch to excite vision. But if this was the way vision actually was excited a certain quantitative relation was to be expected. Rhodopsin does not catch quanta of all wave-lengths equally for, as may be seen from Figure 1, green light of wave-length 500 mμ is best absorbed whereas red light is hardly absorbed at all. Light which is not caught cannot be used, so we should expect that vision by rhodopsin would be best for wave-lengths around 500 mμ and for other wave-lengths it would be less according to the absorption spectrum of Figure 1. This curve was in fact determined by Crescitelli and Dartnall upon the rhodopsin extract of a human eye which had been freshly excised at operation. With the consent of patient and surgeon the operation was performed in red light and so the pigment was obtained unbleached. The curve of Figure 1, then, gives the *absorption spectrum* of human rhodopsin ; how are we to find the curve to compare with it, the *spectral sensitivity* of vision by the use of rhodopsin ?

The rods

Now as Boll and Kuhne saw under the microscope, rhodopsin is contained in the rods but not in the cones, so it will be in rod vision that we must look for our comparison sensitivity curve. That is in twilight vision. Schultze compared the retinal histology in animals of diurnal and nocturnal habits and found that rods were associated with night life. The use of rods in twilight vision has since been confirmed by a multitude of investigations, notably in the analysis of visual functions in man by Hecht and his colleagues. The twilight visibility curve taken from Crawford's accurate studies is shown in Figure 1 by the circles, and the good agreement with the curve is very strong support for our belief that in twilight vision we use rhodopsin and only rhodopsin to catch the quanta with which we see.

Now it has often been argued that strong light will bleach the rhodopsin away so that there will be very little left, and in that condition rods will be largely deprived of their quantum-catching power and so will be pretty insensitive. On the other hand in the dark the pigment will regenerate, so little by little the catching power and hence the sensitivity will return.

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It is a fact that bright lights reduce very greatly the twilight sensitivity and that this slowly returns in the dark, and so it is possible that the explanation might be as above.   But there is a great gulf in biology between what is possible and what is true.   How can we find out if the explanation is true ?   The way to find out is to compare the change in sensitivity with the change in rhodopsin content in the human eye.   When the rhodopsin is half gone do we need twice the light intensity to see? Measurements of sensitivity in dark adaptation are very well known, but measurements of the pigment in the living human eye are sufficiently novel to merit description.

If the *fundus oculi* is examined in an ophthalmoscope superficial irregularities of the choroid can easily be seen, so light is reflected to the observer from regions behind the retina, and such light has passed twice through the retina, and suffered absorption by the retinal pigments.   The more the pigment the more the absorption, so the amount of rhodopsin at any

Rate of bleaching of Rhodopsin
in the left eye of Dr. E. J. Denton on May 15, 1954

O   at the blind spot

X   at the fovea

●   15° parafoveal

The curve is the theoretical exponential bleaching curve

Bleaching
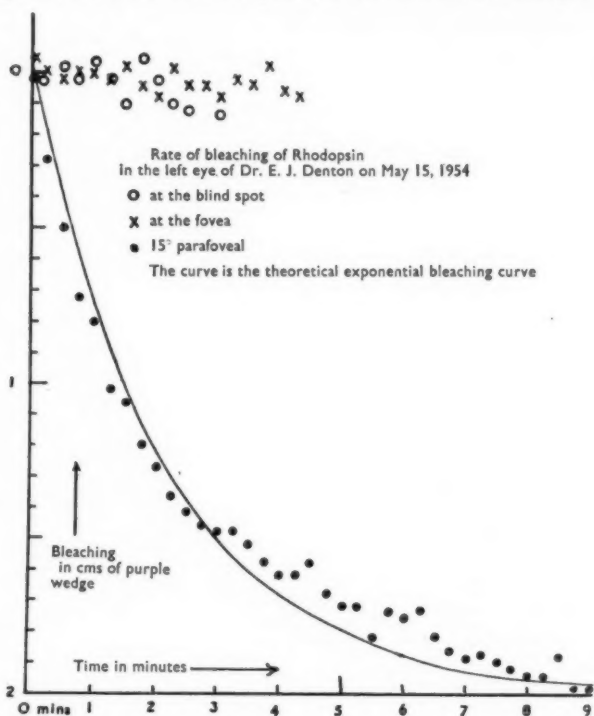in cms of purple
wedge

Time in minutes ⟶

Fig. 2.   Bleaching of rhodopsin in the eye of Dr. E. J. Denton.   Abscissae time in mins., ordinates change of density measured on the optic disc (circles), the fovea (crosses) and 15 deg. parafoveal (dots).

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moment may be measured by observing the intensity of light returning from the fundus.

This light is received upon a photomultiplier cell and many precautions have to be taken to ensure that changes of light are due to changes in rhodopsin and to nothing else. When these are taken we obtain results such as are shown in Figures 2, 3 and 4. Figure 2 shows the fall in concentration of rhodopsin under the influence of a bright bleaching light when the region observed was the rod-rich region 15 deg. temporal to the fovea. This exponential curve is exactly what was to be expected of a visual pigment which bleaches less and less, the smaller the quantity of pigment remaining to catch the light. But what about the two regions of retina which contain no rhodopsin, the optic disc which has no receptors and the fovea which has no rods? Figure 2 shows that these two places which lack rhodopsin lack also any change in light reflectivity after " bleaching, " for the crosses and circles remain near their initial values.

Figure 2 has shown that regions with no rods have no change on bleaching, but a region rich in rods has a large change. What do we find with other parts of the retina which vary in rod concentration? In Figure 3 the curve is Østerberg's determination of the number of rods per
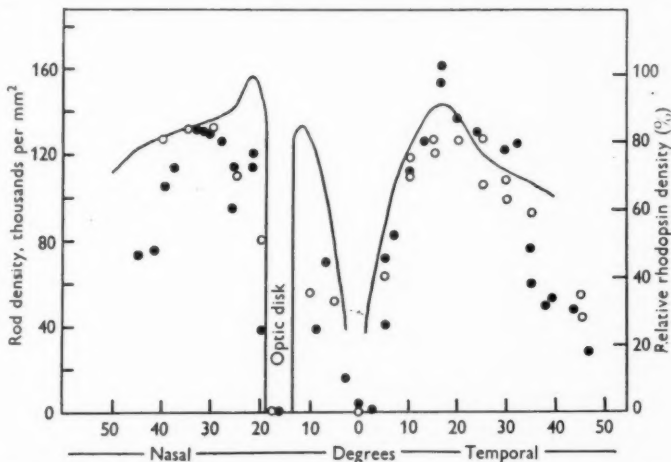
Fig. 3. The Curve gives Østerberg's count of rod density at various parts of the retina. Points show rhodopsin density in author's eye measured by two methods. (From Campbell, F. W. and Rushton, W. A. H., 1955, *J. Physiol.* **130**, 131.)

square mm. at various distances from the fovea as found by direct counting under the microscope. The points are the estimates of rhodopsin in the corresponding regions of my eye made by Campbell by observing how much change occurred in the reflected light after a total bleach. It confirms the observation that there is no rhodopsin on fovea or blind

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spot, and in other regions the amount goes hand in hand with the rod density. It is clear that light can bleach away all the rhodopsin if it is strong enough, but how strong is that? Figure 4 shows that to bleach only a quarter of the rhodopsin, a steady light of about 1 unit of 20,000 trolands is needed (i.e. 20,000 times the brightness of a white screen
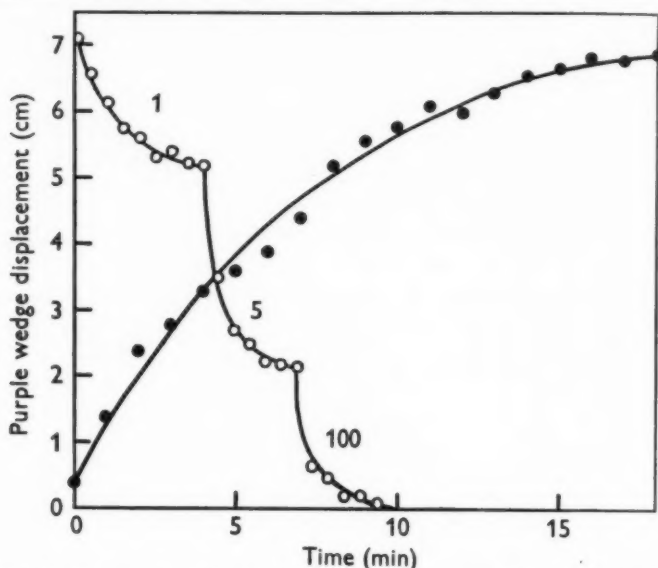

Fig. 4. The course of bleaching of rhodopsin by lights of different intensities applied in succession (circles) followed by regeneration in the dark (dots). Light intensity in units of 20,000 trolands. (From Campbell, F. W., and Rushton, W. A. H., 1955, *J. Physiol.* **130**, 131.)

illuminated by a candle one metre away and viewed through a 2 mm. pupil). To bleach all away needs 100 times this brightness.

This is far outside the range usually employed in dark adaptation experiments, and some hundred-fold change in sensitivity may result from a light whose rhodopsin bleaching is undetectable.

Figure 4 shows also the curve of regeneration of rhodopsin in the dark (black points). But it must not be claimed that this is returning hand in hand with rod sensitivity, for over the whole of this time *there is no rod sensitivity*. For thirty-five years it has been known that after a bright light adaptation some minutes must elapse in the dark before rods regain their function, and that this time is longer the brighter the light. With the full bleach of Figure 4 the rods do not enter till after twenty minutes in the dark have elapsed, therefore no measurable rod function can be associated with any rhodopsin change which is easily measurable: rods

appear to function only when nearly the full compliment of rhodopsin has been restored.

These observations may seem strange to some since they are contrary to the explanation of dark adaptation implied in most text-books. I urge you to weigh them nevertheless from considerations both of truth and of beauty.

The view that light adaptation is the destruction of quantum-catching by bleaching of pigment must rest upon knowing by how much the threshold is raised when the rhodopsin is (say) half bleached. You have just seen the only human measurements that have ever been published, and they show this text-book view to be untenable by several orders of magnitude. For when the pigment is half gone the threshold is not doubled but raised at least 1,000-fold where it vanishes from sight above the threshold of the cones. Consider now the beauty which the new facts reveal in the eyes' mode of operation.

If indeed the loss in sensitivity as light increased *were* due to rhodopsin being bleached, nothing but loss could come of it ; light would pass by unabsorbed and hence unheeded. What a pity that regeneration could not be speeded up a little to keep pace with the bleaching so long as rods were being used, so that we might have full benefit of all the quanta which could be caught. Well, that is just what *is* done. Rhodopsin remains near its maximum so long as rods are in use, and the full number of quanta catchable by this pigment are caught and cleverly caught at that. We earlier spoke of dark adaptation with large nets, long trawls and fair catches but with a poor space-time localization. With richer shoals we may sacrifice yield for precision.

In light adaptation the loss of sensitivity is no more loss than is money spent on a valuable purchase. It is the exchange of unnecessary bright-ness for improvement in acuity and in the rapidity of response.

But I have overstated the case if I suggested that pigment bleaching had *no* effect upon the course of dark adaptation. The effect is not just a change in quantum catching, but the completion of dark adaptation waits upon the full regeneration of the visual pigment. This is about thirty minutes for the rods and eight minutes for the cones in man, and some ninety minutes for rods in the cat, and in each case the sensitivity reaches its maximum at about the same time. If the retina has to adjust itself nicely as between sensitivity and precision for various light levels, something has to indicate what the level is ; perhaps for the rods, the index is derived from the proportion of rhodopsin which is at that time bleached.

The cones

Twilight vision is devoid of colour : to see colours we must use our cones, and in order to distinguish red from green on the *fovea centralis* we must have at least two kinds of cone—one more sensitive to red and

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one more sensitive to green. What is the pigment or pigments which catch quanta in the cones? Some have suggested that all cones contain the same pigment which might be rhodopsin, or might be something else. If this scheme is to work, the red-sensitive cones must be provided with a red window, the green sensitive with a green window in order to confer upon the pigment some differential sensitivity. Such a system has been used in colour photography where red, green and blue starch grains sprayed in front of the sensitive emulsion make the Ag Br crystal behind the red grain relatively red sensitive, behind the green, relatively green sensitive and so on. This scheme seems also to be employed in the retinas of fowls, for different cones have different coloured oil drops through which light must pass before reaching the visual pigments in the outer segments.

The human retina has no coloured oil droplets nor have histologists been able to detect any difference in colour between one cone and another. Nevertheless ingenious theories have been proposed which imagine interference filters, wave guides or some such device situated in front of the visual pigment of the cones to select the rays absorbed, and thus confer colour discrimination.

Now if it were true that we could tell one colour from another only by virtue of the selectors in front of the cones, we should have no colour discrimination for light entering the retina from behind. Such light would fall equally upon the same pigment in all the cones as it does normally upon the rods, and it would appear always a monochrome as it does there.

Brindley and I put this matter to the test on our own eyes. We anaesthetized with cocain and led monochromatic light round to the back of the eye by passing the rays up the axis of a glass rod pushed as far as practicable into the lateral fornix. The glass was ground so that the end of the rod pressed flat upon the sclera, and by rotating the eye fully in the nasal direction we could see the pressure phosphene at about 30 deg. from the fovea. When the light through the glass rod was turned on, the phosphene was replaced by a much brighter patch of colour. For all wave-lengths longer than 500 mμ the colour of the patch seen transsclerally was the same as the colour of the same wave-length simultaneously projected upon white sticking plaster on the bridge of the nose. This could be observed upon an adjacent retinal region and so the colours could be rather well compared. Lights bluer than blue-green did not appear the same by trans-scleral illumination, for the absorption of such light in the choroid is so great that only sufficient intensity reached the retina to stimulate the rods, and the typical sensation of twilight vision alone was experienced.

The fact that colours look the same no matter whether the light falls upon the retina from the front or from the back is not easy to reconcile with a single visual pigment combined with special colour selectors in

front of the cones, but it is exactly what would be expected if each kind of cone had its own special visual pigment.   For the relative amounts of red-sensitive and green-sensitive pigment bleached, say, by yellow light would depend simply upon the particular pigments involved and hardly at all upon the direction of the light.

What, then, are the pigments involved ?

The methods of extraction which, as we have seen, gave such accurate results in the measurement of rhodopsin, fail completely for the cone pigments in mammals.   The only serious claim to an extract of vertebral cones is that of Wald and of Bliss from the predominantly cone eyes of fowls, and this work is so tricky that no one has adequately confirmed it.   Yet surprisingly enough, the method by which Campbell and I measured rhodopsin upon the living human *fundus*, may be applied to the fovea to give useful information about cone pigments.   The fovea is beautifully organized and it contains a perfect segregation of tightly packed cones all orientated for the maximum absorption of light.   In reflexion densitometry we make good use of this organization and so have an advantage over those who start investigating the retina by grinding it to pulp and extracting with powerful solvents.   But we also have our limitations, for the light must be restricted to the fovea which is only 0.3 mm^2 in area, the brightness of light falling upon it must not be great enough to bleach away the pigments, and of that small amount which enters only 1/40,000 comes out again to form the basis of our measure-
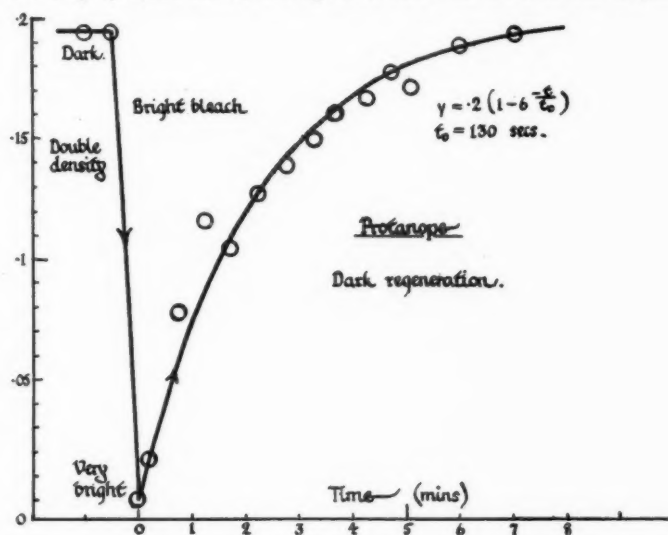

$$y = \cdot 2 \left(1 - 6^{-\frac{t}{t_0}}\right)$$
$$t_0 = 130 \text{ secs.}$$

Fig. 5.   Bleaching and regeneration of cone pigment measured upon the fovea of the protanope.

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ments.   So we have been forced to devise some rather sensitive equip-
ment.   Even so we have not been able to make satisfactory measurements
in the blue part of the spectrum, so in what follows I shall speak only about
the red-green range of colours.

The simplest fovea to study and to describe is that of the protanope—
the type of colour blind who cannot tell red from green and for whom
deep red appears nearly black.   These have often been called " red
blind," and so they are.

Figure 5 shows the change of pigment measured on the fovea of a
protanope.   It started with a density of 0.2 and a strong light bleached
it all away in half a minute and it then took about eight minutes to re-
generate.   This is quite a different time course of recovery from rhodopsin
(Figure 4) and fits the well-known facts of dark adaptation where cones
adapt in five to ten minutes, rods in twenty to forty minutes.   If this
visual pigment consisted of a mixture of green- and red-sensitive compon-
ents, we should expect to get quite different effects by partial bleaching
with red and green light, for red light would bleach chiefly the red-
sensitive component, and green light chiefly the green-sensitive compon-
ent.   In Figure 6 is seen the difference spectrum resulting from a partial
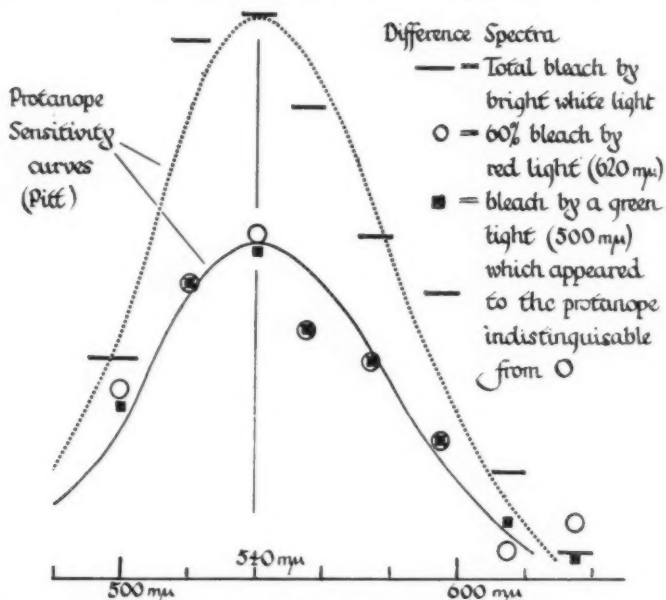bleach with red and with green lights and it is plain that they both give

Fig. 6.   Difference spectrum of foveal pigment of the protanope on partial bleaching
by red or green light.

the same result. So there is only one and not two pigments in the red-green spectral range of the protanope.

But if they have only one visual pigment in this range we should expect them to respond to the cone pigment as in twilight we respond to rhodopsin. Namely they should not be able to tell one wave-length of the spectrum from another except as to brightness, and the luminosity curve should coincide with spectral absorption, as it did in Figure 1.

Now the defect of the protanopes is precisely that they cannot tell one colour from another in the red-green range of the spectrum, and the curves drawn in Figure 6 which fit the difference spectrum quite well are in fact the well-known protanope luminosity curves of Pitt.

Let me conclude by showing similar measurements made upon my own eye which has normal colour vision.   When the eye is bleached by a very bright deep red light which the protanope thought dim and which had no effect upon his pigment a change is produced as seen in Figure 7 (black squares).   This shows a pigment which was not in the eye of the protanope at all, for the red light did not bleach him, nor did any bleach
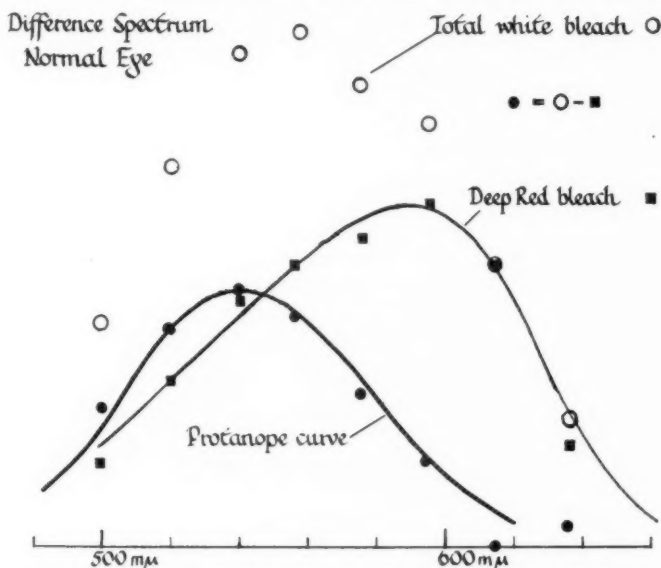
Fig. 7.   Difference spectrum of the author's (normal) eye (squares) with deep red bleach which does not affect protanope pigment ; (dots) with bright white bleach after all the red pigment has been removed.   The curve through the circles is the protanope sensitivity (Pitt). (From Rushton, W.A. H.,   1958, *Nature, Lond.* **182**, 690.)

produce a change in this part of his spectrum.   But when all this red-sensitive pigment has been bleached from my eye, a further total bleach

with bright white light removes the remaining pigment and this differe ce (black circles) is seen to be the same, as was found alone in the protanope, for it *is* the protanope curve which is drawn through the bl ck circles of Figure 7.

We may conclude that the protanope is red blind because he lacks the red-sensitive pigment which normals possess, but the green-sensitive pigment which he has is in fact about twice the amount present in the normal. The microscopic structure of the colour blind retina is normal and he has the usual number of cones, so clearly those cones which in the normal contain the red pigment are in the protanope filled with green. Presumably his recipe for making red-sensitive pigment was lost with the gene which is missing from his X chromosome, he can't make red but he can make green, so he fills all measurable foveal cones with that.

If this physical measurement of living visual pigments is some step towards the understanding of vision and colour blindness it is only a very small one, for the subject is immensely complicated. Yet even this small step would have been impossible without the skilled help of my assistant Clive Hood, and the generous co-operation of the Cambridge physiological students both colour blind and normal. To their steadfast fixation through flashing and gloom and their repeated return for further long sessions of measurements are due whatever success these experiments may have achieved.

ACKNOWLEDGMENTS

We wish to thank the Editors of *Nature* and the *Journal of Physiology* for kindly allowing us to reproduce illustrations which originally appeared in their journals.

ANNUAL GENERAL MEETING AND SCIENTIFIC MEETING
9th December 1959

THE ANNUAL GENERAL Meeting of the College will be held on Wednesday, 9th December 1959, and it is hoped that as many Fellows and Members as possible will attend. The meeting will be held at 3.30 p.m. and will be preceded by the first Watson-Jones Lecture, to be delivered by the Rt. Hon. Lord Cohen of Birkenhead at 2 p.m.

A detailed programme will be published in a forthcoming issue of the Annals.

THE CLOSING MECHANISM BETWEEN STOMACH AND OESOPHAGUS AND ITS IMPORTANCE IN SURGERY OF THE GASTRO-OESOPHAGEAL JUNCTION

by

G. S. Muller Botha,* M.B., Ch.B. (Cape Town), F.R.C.S., Ch.M. (Birm.), F.R.F.P.S.

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JOHN HUNTER'S FRUITFUL exploitations of comparative anatomy were ill understood by his contemporaries and regarded by some as " laborious trifles " in an age when surgeons were far too " careworn and overworked" for such doubtful pastimes. At the present time it is inexcusable not to realise the relations of surgery as a science to physiology, and the dependence of physiology upon comparative anatomy. It is an honour and privilege to deliver this Hunterian Lecture because it was comparative anatomy that gave me the first clue to a proper understanding of the functional activity at the cardia.

The gastro-oesophageal closing mechanism has been a source of controversy for almost three hundred years. Despite countless observations and experiments on the " cardia " our knowledge is still meagre and conflicting, and the vast literature abounds with more fantasy than fact. There are several reasons for the confusion. The importance of anatomy has been over-emphasised. Too many physiological deductions were made in the dissecting room ; and we now know that functional anatomy and the macroscopical appearances in the cadaver are not necessarily the same. Many anatomical observations were also considered as normal which in the light of present experience must be regarded as pathological. Furthermore, the cardia has always been inaccessible ; thoracic anaesthesia was a problem, and some methods of investigation were unreliable. Posture, respiration, peristalsis and cardiac pulsations are but a few of the many controllable and uncontrollable factors which make it so difficult to assess gastro-oesophageal activity accurately, even with the most modern equipment. The two main reasons for the confusion are firstly that many workers have followed *only one line of investigation*, the most recent of which is electro-manometry, and far too many explanations are based on only anatomy or radiology or pressure recordings. Secondly, too many *single* animal species have been rigidly compared with man.

Theories on the closing mechanism

On one fact only is there common agreement : a mechanism of closure must exist which prevents undue reflux of gastric contents into the oesophagus. This mechanism must allow free passage of swallowed material,

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vomiting and effortless eructation of gas ; yet it must effectively close the cardia so that not a drop of fluid will escape despite pressure gradients of 100 mm.Hg across the diaphragm.   The following theories exist :

An intrinsic anatomical or physiological sphincter.
The Pinchcock action of the diaphragm.
A one-way flap valve.
The oblique insertion of the oesophagus and acute angle.
The sling fibres at the incisura.
Occluding mucosal folds at the cardia.
Kinking of the abdominal oesophagus by the right crus.
The liver tunnel.
Positive pressure compression of the abdominal oesophagus.
The phreno-oesophageal membrane.
Compression of the lower oesophagus by the lungs.
Chemical control of the cardia.

The solution to this problem is important.   Only when the normal mechanism of closure is fully understood can we formulate a logical approach to the pathological aberrations which affect this area.   It is also clear that for a full understanding and proper perspective as many methods of investigation should be employed as possible in man as well as in animals.

" Surely there is no field more inviting for research, not only by the radiologist but by the anatomist, physiologist, clinician, biochemist, and pathologist. In fact, the whole team should start afresh and establish what is true.   In this way it may be possible to standardise terminology and put facts and proved theories on a permanent and acceptable foundation."

This challenge of A. S. Johnstone in 1954 stimulated my interest and led to a series of investigations on the closing mechanism.   This lecture briefly summarises the conclusions of some personal investigations and points out how they influence surgical principles.

The cardia

Anatomists regard the cardia as the junction between stomach and oesophagus, but the end of the oesophagus has been placed at : the sling fibres, the incisura, the diaphragmatic constriction, the squamo-glandular junction, and the peritoneal reflection of the stomach.   The cardia has also been taken as the site where the positive intra-gastric pressure changes to a negative intra-oesophageal pressure ;   where active oesophageal peristalsis ends, or at the lower border of the characteristic empty segment during barium swallow examination.

Cardia is an anatomical term for the junctional zone between stomach and oesophagus and may be represented by a line drawn from the centre of the incisura on the greater curve to a point on the lesser curve where the oesophagus broadens out into the stomach (Fig.1b).   Normally this division is easy, but in certain pathological conditions the oesophagus and

(a)   (b)

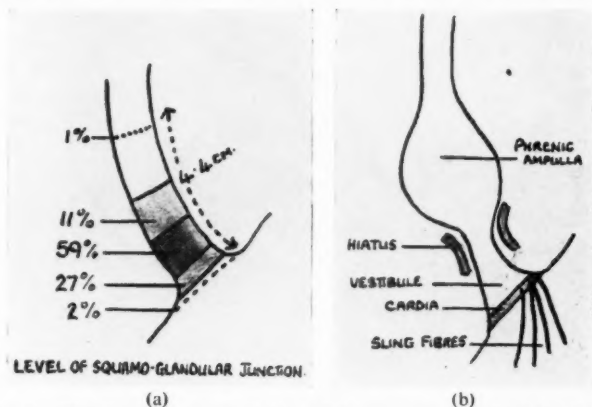Fig. 1.   Diagrammatic representation of the gastro-oesophageal junction :
        (a)   The level of the squamo-glandular junction in 100 specimens.
        (b)   Nomenclature.

stomach become a uniform tube.   Despite statements to the contrary
there is then only one way of identifying the cardia :   the sling fibres

Fig. 2.   The sling fibres seen from the inside of the stomach after removal of the
mucosa.

(Fig. 2). These are already macroscopically obvious in the 75 to 90 m. m. embryo (Botha, 1959a) and can almost always be demonstrated in the adult irrespective of pathology. *The sling fibres are the only absolute indication* of where the oesophagus ends and the stomach begins. The squamo-glandular junction bears no constant relationship to the cardia (Fig. 1a). In man it varies from just below the cardia to the epiglottis. In the rat and horse it is well into the stomach ; in the bat (Fig. 8) and sturgeon well into the oesophagus. Tested by this junction, many vertebrates will thus lack a true stomach whereas others will have no gullet (Botha, 1958a). The level of mucosal change is a species characteristic which is quite unrelated to where the oesophagus ends and the stomach begins. It so happens that in the vast majority of people it takes place at or near the cardia.

ANATOMY

Prepared specimens of the gastro-oesophageal region were studied from 150 infants, children and adults. Considerable variation occurs, the functional significance of which has not been fully appreciated.

Diaphragm

In the standard pattern the aorta divides the crural muscle into a right and left crus. The right crus is generally better developed than the left one, and consists of a large right and a smaller left limb which embrace the gullet and join again anteriorly. The right limb fibres are straight and anterior ; the left ones are oblique and posterior, an arrangement which results in perfect overlap. Deviations from the standard pattern are common. Thus the hiatus may be a mere slit in the right crus without any overlap or the left limb may disappear so that the right and left crura form a scissors overlap which may be single, double or treble (Fig. 3). The hiatus may even be formed entirely by the left crus (Botha, 1958b). Additional oblique or transverse bands of muscle often occur dorsally near the hiatus. When well developed these bands are important as added support to maintain the normal anatomical relations of the stomach and oesophagus ; to aid the closing mechanism by narrowing the hiatal opening ; and to re-inforce the posterior " weak spot " of the diaphragm.

The significance of overlap cannot be over-emphasised. It is most marked in the standard pattern and serves three purposes :

1. To strengthen a potentially weak area. Clinical weakness never occurs in front but there is little stability behind where the criss-cross fibres may be easily separated by a force that acts on the hiatus. Overlap is the best way in which Nature provides the greatest protection for the weakest area with minimum available tissue.

2. To maintain an oblique hiatus which is essential for a snug accommodation of the lower oesophagus during physiological movements.

Fig. 3.   Treble overlap of the crura seen from below.

3.   To change the alignment of the muscle fibres so that both the transverse and the longitudinal diameters of the hiatus would be decreased during diaphragmatic contraction.

The hiatus might be well forward or it may almost approximate the aortic opening. The shape tends to become more circular with age. The hiatus is generally wider in older subjects although a large hiatus may be found in a young person, or a very small one in a patient of seventy (Fig. 4). In one subject where a hiatal hernia was discovered at post mortem the hiatus was large and the crural ring attenuated and thin ; in another with hiatal hernia the hiatus was relatively small, smaller than in many others where there was no sign of herniation.

There is little anatomical justification for the term crural tunnel.   The anterior wall is seldom longer than 5 to 10 mm. but the posterior wall is often 1.5 cm. long.

The postero-medial branches of the phrenic nerves innervate all muscle

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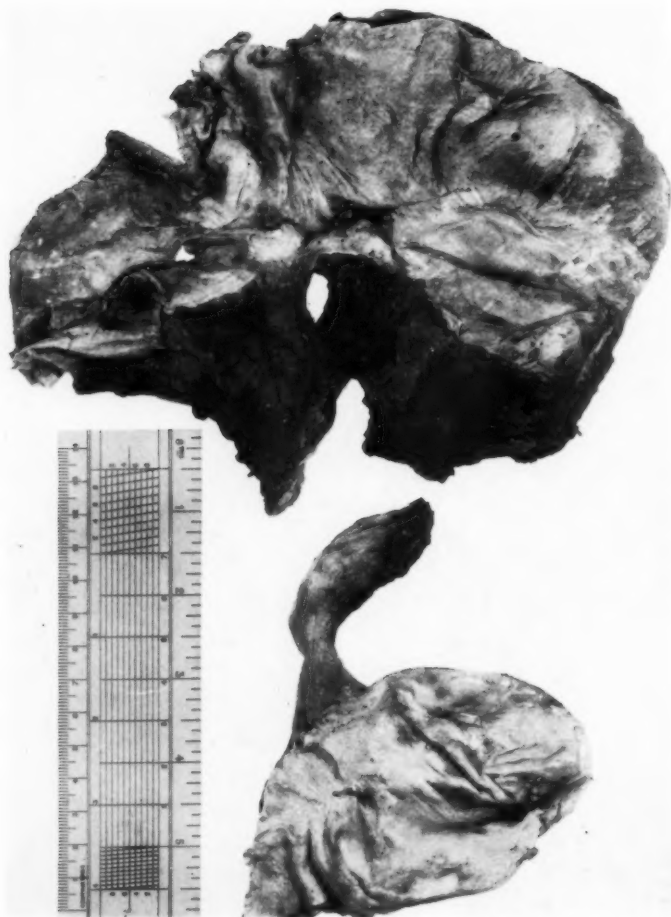
Fig. 4.   The undersurface of a diaphragm from a woman of seventy.   Note good overlap and small hiatus.   The tight constriction on the oesophagus is conspicuous.

on the ipsilateral side of the hiatus irrespective of whether they belong to the right or left crus (Botha, 1957b).

The phreno-oesophageal membrane

This closely woven, creamy-white fibro-elastic membrane bridges across the potential gap of the hiatus and forms the only true fixation of the gastro-oesophageal junction to the diaphragm. It is normally well developed, but attenuated in cases of hiatus hernia. Resiliency and

strength is due to the high proportion of elastic fibres which make the membrane admirably adapted to stand the strain of incessant movement at the hiatus.

The inferior oesophageal sphincter

Adequate inspection of the muscle is only possible after complete removal of the mucosa and submucosa. Anatomical sphincters in the terminal oesophagus cannot be refuted on histological evidence alone or because they do not resemble those at the pylorus. In the majority of specimens the inner circular muscle layer thickens towards the cardia. In a few a more localised thickening is present which always extends for some distance *above* the cardia, being thickest in the centre and thinner towards the edges (Fig. 5). The fibres are coarse, lighter in colour and

Fig. 5. A definite sphincteric thickening of the muscle fibres after removal of the mucous membrane.

interdigitate freely. Although anatomical sphincters are absent in the majority of people there can be no doubt that they exist.

Mucosal folds at the cardia

The longitudinal folds of oesophageal mucosa continue uniformly o
the cardia unaffected by the level of mucosal transition. There they fade
away, enlarge to triangular padded elevations or continue directly into
gastric folds. A radiating stellate arrangement is commonly present. The
cardiac orifice is relatively tight and closed in young subjects but gener-
ally wider and more patulous in the elderly. In one preparation a perfect
water-tight mucosal seal was present at the cardia which closely resembled
a mitral valve (Fig. 6). In another specimen a large voluminous flap of

Fig. 6. A longitudinal section through the gastro-oesophageal junction. Note
the vestibule above the mucosal folds at the cardiac orifice.

gastric mucosa was hinged on the greater curve side of the cardia and
effectively plugged the oesophageal opening (Botha, 1958c). Most of
these special folds are not seen at autopsy due to post mortem changes in
the functional anatomy.

Muscularis mucosae

Both smooth muscle layers of the muscularis were thickened at the
cardia (Fig. 7). The fibres were increased in number and arranged more
irregularly. Their attachment to the epithelium and muscle layers often
resulted in a tethered appearance.

COMPARATIVE ANATOMY

A histological and macroscopical study of the gastro-oesophageal
junction was carried out in twenty-one different species (Botha, 1958a).

Fig. 7   Fig. 8

Fig. 7. A longitudinal section through the gastro-oesophageal junction($\times$ 2) in man.
Note the large fold of mucosa at the cardiac orifice and the well-developed muscu-
laris mucosa.
Fig. 8. A longitudinal section of the gastro-oesophageal junction in the bat.
Note the high level of squamo-glandular junction, the ring-like sphincter at the
cardia and the fold of mucosa at the cardiac orifice.

Mucosal folds

Gastric mucosal folds at the cardia may be squamous or glandular, but
they bear no relationship to the level of mucosal change. The most
perfect example of occluding folds is seen in the tortoise. In the absence
of a diaphragm, acute angle or macroscopical sphincter, these folds must
be the main factor which prevents the forcible ejection of gastric content

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Fig. 9. A longitudinal section through the gastro-oesophageal junction in the
rabbit. Note the massive sphincter and the fold of mucosa at the cardiac orifice.

when the stomach contracts. In the rabbit a perfect mucosal rosette seals
the orifice. In the bat the cardiac mucosa simulates a " cork," which
is as important as the ring-like sphincter in preventing the stomach from
emptying by gravity. In the cat, dog and monkey numerous irregular
folds are seen at the cardia in fresh specimens, but they disappear a few

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hours after death. The surface is then smooth and glazed as is so com-
monly seen in the human stomach at autopsy. In the horse a honeycomb
of thick mucosal ridges occludes the orifice. In the rat and hamster two
mucosal lips approximate at the cardiac orifice. In the pig, flaplike folds
were often present. In ruminants the cardiac orifice is particularly
smooth and open.

The internal sphincter

In some species (dog, cat, ferret and monkey) no macroscopical sphincter
could be identified. In others a conspicuous anatomical sphincter is
present, as a localised thickening in the muscle coat (bat and rabbit, Figs.
8 and 9) or a gradual increase in the thickness of the muscle (horse and
pig). The level varies. It is low in the pig, at the cardia in the bat and
cranial to it in the hamster and rat. It may consist of entirely striated
muscle (mouse), entirely smooth muscle (bat) or both (rabbit), (Botha,
1958d). Even in those animals where no macroscopical sphincter is
apparent, the lower oesophagus is narrow and somewhat constricted at
the cardia (dog, cat) or immediately cranial to this level (ferret).

Sling fibres

In the tortoise these muscle fibres are either absent or hardly percept-
ible, yet a good incisura exists. No oblique fibres were demonstrated in
the frog although there was a definite deviation to the left. In the rat
a criss-cross of greater and lesser curve sling fibres occur on the ventral
and dorsal gastric surfaces. In the larger mammals the sling is character-
istic at the cardia. It possibly fulfils a useful function in constricting
the cardiac orifice by pulling caudally as well as opposing the ventral
and dorsal walls.

The cardiac angle

The upper digestive canal is a straight tube in the dogfish. In amphibia
a fusiform dilatation appears which bulges to the left of the mid-line.
In reptiles the stomach becomes a left sided organ ; the angle is obvious
but the fundus still insignificant. Only in the mammalian series does the
fundus develop fully. The sharp cardiac incisura is therefore a late
manifestation in the evolution of the stomach, and a characteristic feature
which varies with the functional specialization of the organ.

The diaphragm

Except for minor variations, the crura are very similar in the different
species. There are important fundamental differences in crural anatomy
between animals and man. Overlap, which is so significant in the standard
human pattern, was not seen in a single animal specimen. When the
diaphragm contracts any constricting effect can therefore only be due to

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a rise in tension in the two parallel hiatal margins. This has been par ly compensated for by the adaptation of a bipennate right crus in the ho: se and the oblique origin of the left limb (right crus) in the dog (Bot a, 1958a). In most animals the hiatus moves caudally only, as opposed to man where it moves to the right as well. Another distinct difference is the smallness of the round or oval hiatus in man ; in animals it is a w de and lax slit. In some animals the diaphragm can play no possible role in gastro-oesophageal competence as it is situated well above the cardia (rat, kangaroo), so that at least in these species (or where it is entirely absent) other components are acting in the closing mechanism. The crura support the gastro-oesophageal junction and when specially adapted may even constitute an important additional component in the mechanism.

OBSERVATIONS AT OPERATION

The inside and outside of the gastro-oesophageal junction was inspected and palpated in twelve patients during partial gastrectomy for peptic ulcer (Botha, 1958e).

The functional anatomy varied considerably. On gentle palpation the cardiac orifice was at first missed in two patients ; in others it was wide open and patulous, readily admitting the finger. Mucosal folds were present at the cardia in all patients but varied in size, form and tone. Despite the variations under anaesthesia, subsequent barium meal examinations showed in all these cases that the mucosal seal was perfect. In every patient part of the oesophagus was in the abdomen but the length varied. In six subjects an area of hypertonus was felt in the lower oesophagus which was minimal at the cardia but maximal 1 to 2 cm. above. There was no evidence to suggest a mechanical valve at the cardia. The constricting action of the crura and the tightness of the hiatus cannot be assessed from the outside of the stomach. In one patient the hiatus was very small ; post-operative barium swallow confirmed excellent function. On deep inspiration in the erect position the bolus of barium was obstructed completely for as long as diaphragmatic contraction was maintained. In other subjects the hiatus was wide with little or no constriction, even during inspiration, but in all cases it could be felt as an external support. Curarization relaxed the cardiac region ; the difference was as marked as that between a normal anal canal and a prolapsed rectum.

RADIOLOGICAL OBSERVATIONS

The anterior edge of the diaphragmatic hiatus was marked with a metal clip at laparotomy in twenty patients and examined post-operatively in relation to the diaphragm (Botha, 1957a). The position of the clip did not necessarily correspond to the level of the diaphragm and there was considerable variation from patient to patient in its position as well as in its movements. This is significant for two reasons. First it means

that various conclusions about the nature of the gastro-oesophageal closing mechanism have to be reconsidered, e.g. manometric studies and fluoroscopic observations, and secondly, it is important in the diagnosis of lesions in this region. In most people the anterior hiatal margin is situated above the line that indicates the diaphragm radiologically. In only a minority is it at or below this level. During inspiration it moves downwards, inwards and slightly backwards. At the same time the dome moves down relatively more than the clip so that the gastro-oesophageal angle is opened. The wide variation in position and activity of the hiatus further suggests that crural function is not the same in every patient.

During barium swallow examination a characteristic " empty segment " of 2 to 3 cm. is present in the terminal oesophagus (Fig. 10). This segment momentarily relaxes ahead of peristaltic contractions, oesophageal contents pass through and the segment becomes empty again. The
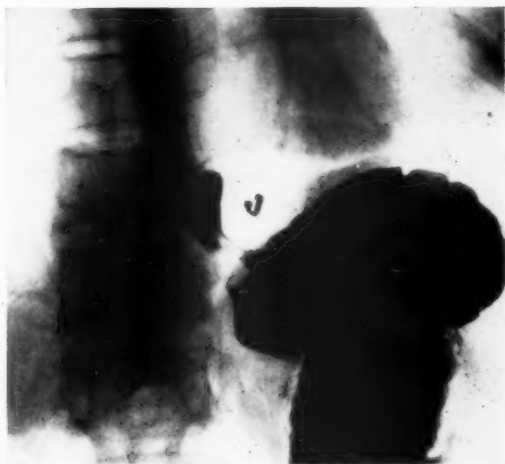

Fig. 10. The characteristic empty segment in the terminal oesophagus. The clip was attached to the undersurface of the anterior hiatal margin at a previous laparotomy.

" empty segment " was also demonstrated in long thin balloons filled with radio-opaque fluid (Fig. 11). Although the lower end of the segment is always at the cardia, its upper border sometimes extends above the clip. At least part of this segment lies undoubtedly outside the crural canal, and the only possible thing that can keep it empty is contraction of the inferior oesophageal sphincter. The constricting action of the crura at the level of the clip is conspicuous in some individuals on deep inspiration. The mucosal folds at the cardiac orifice are often circular, stellate or crescentric and produce a water-tight seal flush with the rest of the gastric
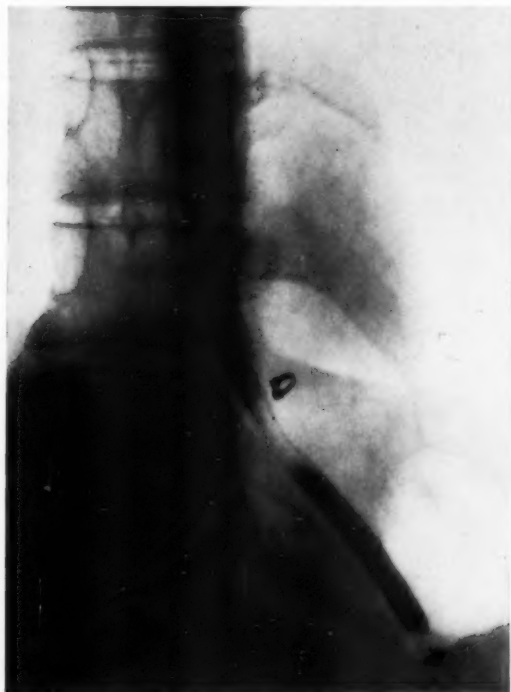
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Fig. 11. The empty segment is demonstrated by this balloon filled with radio-opaque fluid.

wall so that there is hardly ever a horn of barium pointing into the oesophageal opening. Firm mucosal apposition is the only factor which could account for this constant radiological finding.

There was no evidence for a mechanical valve. If the greater curve passively flaps against the lesser curve, as is popularly believed, then the terminal oesophagus must be flat from the sides; instead it is always broader at the cardia than immediately above it. Further, the abdominal oesophagus deviates sharply to the left so that the gastro-oesophageal angle is commonly 90 deg. or more. It is difficult to visualize a flap under such conditions and even more difficult to explain how a flap can cause such a long empty segment.

COMPARATIVE PHYSIOLOGY

The study of pure anatomy seldom provides complete physiological answers. It is futile to study the closing mechanism by constructing models, or by doing " physiological " experiments on the cadaver or,

worse even, on isolated organs. Acute experiments were therefore conducted under light anaesthesia (Botha and Nunn, 1957) in thirteen different species, in which the functional activity of the gastro-oesophageal junction was studied directly (Botha, 1958c). Cinematographic recordings were made in eleven species.

Conclusions

1. There was a striking difference between the functional anatomy and the macroscopic appearance of the dissected specimens.

2. The activity at the cardia depended essentially on the type of muscle fibre. The level at which striped fibres changed to smooth ones varied from the cardia to the aortic arch. Primary peristalsis (initiated centrally by the swallowing reflex) and secondary peristalsis (initiated locally and independent of swallowing) are indistinguishable in the lower oesophagus. They are extremely rapid and forceful in the striated portion, slow and wormlike in the smooth portion, and considerably delayed in the terminal vestibular portion. Distension of the oesophagus immediately initiated secondary contractions which continued until the distension was relieved or the contents pushed into the stomach.

3. In the rabbit, guinea-pig and pig incision of the hiatus had no effect on competence. In the cat, ferret and monkey reflux was easier after incision of the hiatus. In all, the fundus was depressed on left
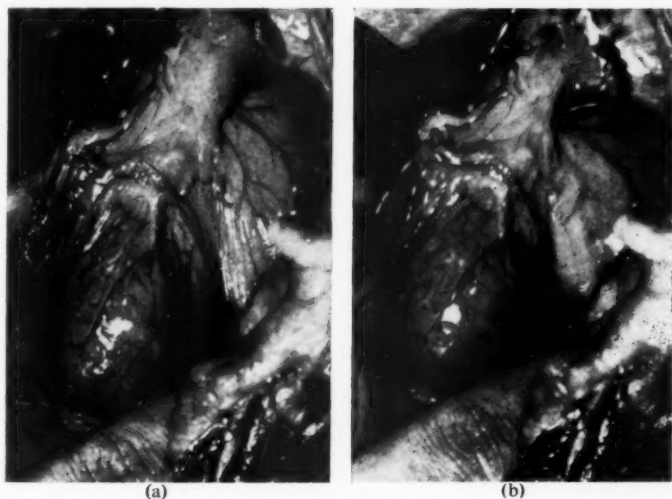

(a)   (b)

Fig. 12. The gastro-oesophageal junction in the dog seen from the abdomen :
(a) Before nerve stimulation.
(b) During stimulation of the left phrenic nerve. The left hiatal sling nips the oesophagus on the left while the dome descends and pushes the fundus downwards so that the angle is opened (from 16 mm. cine film).

phrenic nerve stimulation and the angle was widened. In addition slight nipping of the terminal oesophagus occurred, most marked in the dog (Fig.12).

4. There was evidence of a physiological sphincter in all mammalian species, but the activity of the sphincter and the force with which it contracted varied tremendously. In the rabbit it was so powerful that the stomach was torn without producing reflux, and it is not surprising therefore that the rabbit cannot vomit (Fig. 13). In the cat and monkey
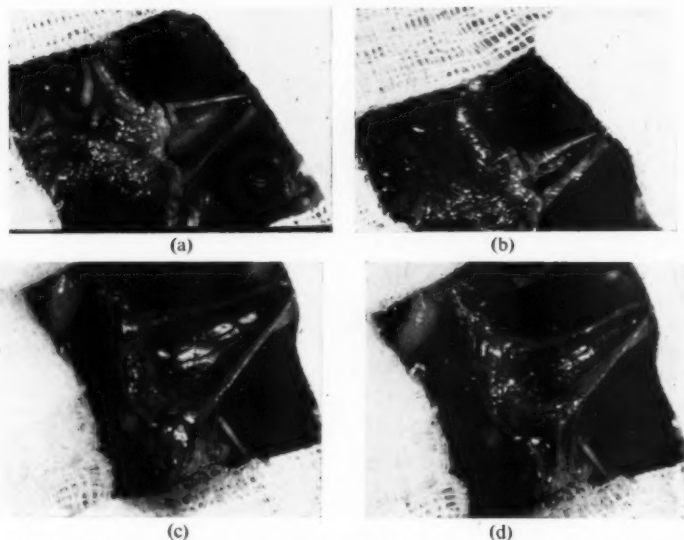
Fig. 13. The gastro-oesophageal junction in the rabbit opened longitudinally :
(a) Before and (b) during stimulation of the vagus nerve.
(c) and (d) The mucosa has been removed. (a) Before and (b) during stimulation of the vagus nerve (from 16 mm. cine film).

it was only evident as an area of hypertonicity above the cardia. On stimulation of the vagus inhibitory fibres relax the sphincter. Stimulation of the splanchnic nerves has little effect but after vagal section they produce unquestionable contraction of the sphincter.

5. Mucosal folds of varying size, shape and position were present at the cardiac orifice in all species (Fig. 14). These closed the orifice flush with the gastric wall and produced a watertight seal. The folds were not passive but contained intrinsic tone which could only have been due to the thickened muscularis mucosa. Excessive handling of the folds disturbed this contractile element so that the folds became floppy. Competence was always best at the beginning of an experiment ; towards the end reflux sometimes occurred spontaneously.
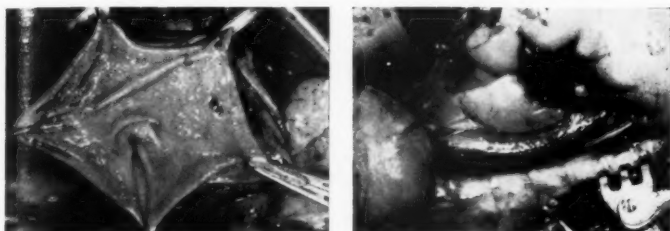
(a)   (b)

Fig. 14.
(a) The mucosal folds in the ferret.
(b) The physiological sphincter in the ferret. Note the contracted
     terminal segment (from 16 mm. cine film).

6. There was no evidence of a flap-valve mechanism. In the rat, rabbit and bat where the sphincter was well developed, the angle could be straightened completely without affecting competence. Although no anatomical sphincter could be seen in the pig, the physiological sphincter and mucosal folds together were sufficient to resist considerable compression of the stomach in spite of incision of the hiatus and obliteration of the angle. In the cat and monkey reflux becomes easier if the angle is widened and a funnel is produced at the cardiac orifice.

CINERADIOGRAPHIC AND MANOMETRIC STUDIES

A combined cineradiographic and manometric study of the gastro-oesophageal junction was carried out in twenty adult volunteers (Botha, Astley and Carré, 1957), and in monkeys and rabbits (Botha and Astley, 1959). Manometric studies alone were also carried out in a further twenty patients and eight different animal species.

Conclusions in man

1. On withdrawal of a polythene tube from the stomach into the thoracic oesophagus a zone of higher pressure was recorded in all subjects, but it varied considerably in different individuals and even in the same subject from moment to moment. The pressure-rise started at or above the barium outline of the stomach, reached its maximum at or above the diaphragm (as indicated by the hiatal clip and the level of the dome) and fell to general intra-thoracic pressure well above the diaphragm in all cases. The average length of this pressure zone was 2.6 cm. A mechanism must therefore be operating in the lower segment of the oesophagus, which is producing a compressing effect over a few centimetres, a distance which is incompatible with a mechanical flap valve.

2. Similar high-pressure zones were also recorded at the gastro-oesophageal junction in cases of hiatus hernia where the cardia was well above the diaphragm. In one subject who had undergone near-total

gastrectomy normal withdrawal curves were obtained despite obliteration of the angle. Yet this man had no symptoms of reflux and barium meal examination indicated normal gastro-oesophageal competence.

3. There was no constant relationship between the type of withdrawal curve and the phase of respiration. The high-pressure zone was generally more marked on full inspiration. In some it was conspicuous especially if a small balloon (1.5 cc. volume) was withdrawn through the hiatus. Further, in some cases of hiatus hernia a slight rise in pressure occurs at the level of the hiatus. These findings suggest that the hiatus has some constricting effect on full inspiration in most people. In a few it is significant.

In animals

1. Withdrawal curves were very much alike in the different species and indistinguishable from those in man, which suggests the same underlying physiological mechanisms.

2. The rabbit has the most conspicuous high-pressure zone. This animal therefore not only possesses the most convincing anatomical sphincter but it is also physiologically the most powerful. The high-pressure zone was minimal in those animals where sphincteric activity was the poorest during physiological studies.

3. Cineradiography demonstrated an " empty segment " in the terminal oesophagus during barium swallow which closely resembled that in man. This empty segment corresponded with the high-pressure zone.

KYMOGRAPH STUDIES

Gastro-oesophageal activity was recorded on a kymograph balloon system (1.5 to 5 cc. volume) in thirty-eight normal subjects and 339 tracings were studied.

1. On withdrawal of the balloon from the stomach a certain resistance was encountered before it passed into the thorax. This resistance, which is indicated on the kymograph by a substantial positive deflection, varied in different individuals and with the phase of respiration and was generally more marked during inspiration.

2. Withdrawal of a balloon of threshold volume into the lower oesophagus initiated secondary peristaltic contractions. This suggests that reflux and eructation will only initiate peristalsis if the oesophagus is sufficiently distended.

3. Secondary peristalsis protects the oesophagus by keeping the organ empty.

THE CLOSING MECHANISM : CONCLUSIONS

Full agreement on the closing mechanism is unlikely—preconceived ideas and personal opinion are too strong for that—but I hope that the

brief outline of the present investigation has helped to put the subject in proper perspective. The principles of closure are uniform, but the importance of each component depends on the anatomical and physiological variations of the individual, and these variations account for the differences in gastro-oesophageal competence in normal people.

During life mucosal folds of varying size, shape and position are usually in close apposition at the cardiac orifice and effect a watertight seal from below (Fig.15). These folds are not passive; they are controlled and
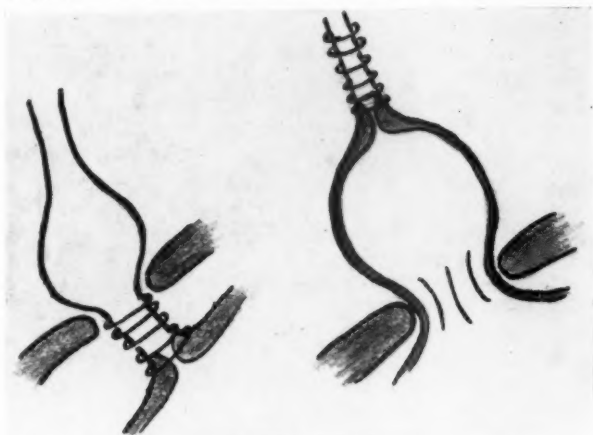

Fig. 15.
(*left*)   The normal competent closing mechanism.
(*right*) In hiatus hernia the closing mechanism is acting at a disadvantage—
the pressure is now not dissipated evenly.

maintained by the active tone of the thickened muscularis mucosa, thus ensuring that there is always a " cork to plug the bottle." By themselves these folds are too weak to withstand any strain, but they are drawn together and apposition is maintained by the inferior oesophageal sphincter. Had it not been for the folds then the sphincter by itself, however strong, would always have left a small conical space where the oesophagus joins the stomach. If this was so, it would be readily detectable radiologically and would constitute a constant invitation to reflux during sudden sharp rises in intra-abdominal pressure. But in fact the pads of mucosa fill this potential space and close the cardiac orifice so flush with the gastric wall that the pressure is dissipated evenly. In this way pressures of 100 mm. Hg. or more are resisted with perfect competence yet the mechanism is flexible enough to allow normal peristalsis and the effortless eructation of gas.

These two factors, the mucosal folds and the internal sphincter, act together in perfectly balanced harmony. Together they form the closing mechanism between the stomach and the oesophagus.

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The diaphragm is not part of the closing mechanism. It is, however, *the* important factor which supports and maintains the abdominal oesophagus and cardia in their normal position, and the closing mechanism can only act with optimum efficiency if the normal anatomical relationships are preserved. That is, if the pressure can be dissipated evenly. In some individuals the crura are well developed, overlap is good and the hiatus is relatively small ; the diaphragm then becomes an important *accessory mechanism* which assists the sphincter particularly when the crura contracts. With advancing age, the hiatus widens and the crural muscle becomes thin and attenuated. The phreno-oesophageal membrane is over-stretched, and the gastro-oesophageal junction is therefore less securely fixed. Excessive sliding, once started, rapidly gets worse. The junction elongates and is gradually displaced into and later through the hiatus into the posterior mediastinum. If the intra-abdominal pressure then suddenly rises, a vicious state of affairs will exist. There is no even distribution of pressure along the gastric wall. Instead, gastric contents rush into the funnel caused by the herniation of the stomach, fill the supra-diaphragmatic loculus, and, if the force is of sufficient magnitude, the deranged closing mechanism gives away and free reflux into the oesophagus takes place (Fig. 15). Not only has the closing mechanism been deprived of the important accessory control of the diaphragm, but under these circumstances this structure may during contraction encourage the incompetence, firstly by squeezing more gastric contents into the tense supra-diaphragmatic loculus ; secondly by further elongation of the junction ; and thirdly by compressing the infra-diaphragmatic portion of the stomach.

Gastric juice is always undesirable in the oesophagus. The closing mechanism prevents it from getting there, but if reflux should take place then the contents must be removed as quickly as possible. This important *emptying mechanism* consists of primary and secondary peristalsis, and its efficiency depends on the integrity of the neuromuscular structure of the oesophagus.

SURGERY OF THE GASTRO-OESOPHAGEAL JUNCTION

Surgery of the gastro-oesophageal junction has been based on the view that the diaphragm and the angle are the two important factors which prevent abnormal reflux. The nature of the closing mechanism has now been established, and the above conclusions indicate that current surgical concepts need re-orientation.

It is obvious that no man-made imitation can ever satisfactorily replace the co-ordinated synergistic action of the normal closing mechanism and the crura. Valve reconstruction operations are therefore futile. Numerous experiments have been carried out in the past, and are still being done, to try to reconstitute a mechanism which would prevent reflux. Personally I can see no future for these surgical exercises. They prove little

in the various animal species except what is already known, and are often so complicated as to be completely unpractical in man. Even the success or failure of valve reconstitution as reported in man does not primarily depend on the efficacy of the valve, but on the resistance of the individual's squamous epithelium to his own gastric or intestinal juices. The factors which determine this resistance are not yet fully understood. Gastric juice in some animals has the same adverse effect on squamous epithelium as in man, whereas in others the gastric secretions are completely innocuous to the squamous lining. For example, the lower oesophagus of the bat is lined by glandular epithelium rich in parietal cells so that hydrochloric acid must collect in the organ when the animal is hanging upside down. Yet, because this is a normal arrangement for the bat, there is no reason to believe that its oesophagus is eroded during the long winter hibernation. Either the epithelium is specially resistant or, more likely, the composition and concentration of the noxious agent varies in different species. Exactly the same applies to man. Some patients with hiatus hernia have excessive reflux for many years without the slightest oesophagitis ; others may suddenly complain of symptoms due to reflux, develop a stricture within weeks and on endoscopy show a diffuse haemorrhagic granulating mucous membrane. The incidence and severity of oesophagitis after gastro-oesophageal anastomosis is equally unpredictable. *There is only one effective barrier to reflux—a normal closing mechanism in the normal position.* It is therefore essential firstly, to preserve the gastro-oesophageal junction whenever possible ; secondly, to maintain the normal anatomical relationships of the cardiac region ; and thirdly, to restore the closing mechanism, when indicated, to the position of optimum function. The success or failure of surgical intervention depends mainly on the proper application of these principles.

I. PRESERVE THE GASTRO-OESOPHAGEAL JUNCTION

The two important components of the junction are the mucosal folds and the sphincter. Thus in order to ensure the function of the closing mechanism it is necessary to preserve the proximal 1 to 2 cm. of stomach and the terminal 3 to 4 cm. of oesophagus. To destroy this segment without sound indications is to deprive the individual of the best protection against the sequelae of oesophagitis. The following examples illustrate this principle :

In partial gastrectomy for peptic ulceration and benign neoplasms this segment should be saved where it is technically possible. The blood supply to the fringe of stomach is good and provided an adequate anastomosis is carried out it may be joined safely to duodenum, stomach or jejunum. This operation is certainly easier via the abdominal approach than the conventional anastomosis to the terminal oesophagus. In a man of twenty-five who had two previous perforations for peptic ulcer, three partial gastrectomies including vagotomy and then perforated again,

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this procedure was carried out successfully. He was subsequently carefully examined by cineradiography and electromanometry. There was no sign of reflux and no symptoms to suggest incompetence of the closing mechanism. The same result was obtained in other patients. Even in malignant conditions of the lower stomach this procedure should be considered seriously. It is doubtful whether the prognosis would be significantly influenced but what a difference it makes to the patient's comfort.

Corrosive strictures of the oesophagus usually involve the upper and middle portions of the organ; the closing mechanism is seldom disturbed. If resection is indicated this type of case is ideally suited for jejunal or colonic transplant because the normal functioning closing mechanism protects the transplant from erosion by gastric juice.

The same principle applies to *reconstruction operations for congenital tracheo-oesophageal fistulae* where primary anastomosis is impossible. The obvious thing is surely to anastomose the colonic transplant to the terminal portion of the oesophagus and not to the stomach directly. The chances of late ulceration must be lower when the squamous epithelium of the oesophageal segment is bathed with a mucoid alkaline secretion instead of acid pepsin, apart from the greater comfort of the patient who retains the mechanism of normal closure, eructation and vomiting.

II. THE NORMAL ANATOMICAL RELATIONSHIPS

The snug embrace of the terminal oesophagus by the hiatal tunnel is predominantly responsible for ensuring that the stomach stays in the abdomen. The importance of the crura in any surgical repair can therefore not be over-emphasised and they should be treated with the greatest respect. Dissection must be gentle. The hiatus should not be widened by stretching or tearing of the muscle fibres. Care should be taken not to damage especially the left phrenic nerve which is the only motor supply to the left hiatal sling. Neither phrenic nerve should ever be crushed without sound indications. The phreno-oesophageal membrane in the normal subject also serves as an important anchor to prevent excessive slide of the gastro-oesophageal junction. Once this membrane has been overstretched and the elastic fibres have fragmented, it loses its function and surgical reconstitution becomes unsatisfactory, and of doubtful value.

It has already been pointed out that the junction is not merely another piece of digestive tube but a specialised segment which contracts and relaxes so as to allow food to pass into the stomach and gas to escape into the oesophagus. This balanced mechanism can only act efficiently if its nerve supply is intact. Damage to the vagi should therefore be avoided during dissection, diathermy and ligation. Injury to the vagi also has other adverse effects. Firstly, over-action of the pyloric sphincter leads

to gastric stasis which, together with the loss of gastric tone, accentuates dilatation. If intra-abdominal pressure should then rise, reflux would be easier; the very thing which one wants to avoid. Secondly, bowel distension immediately after operation is troublesome and may amount to extreme discomfort. Thirdly, this distension increases the intra-abdominal pressure and encourages reflux. It also puts an undesirable strain on the hiatal repair and the incision in the diaphragm before healing has taken place.

III. REDUCTION OF THE CLOSING MECHANISM

Surgery is not necessarily indicated in every case in which the gastro-oesophageal junction is displaced from its normal position, but it should always be considered as potentially dangerous. In infants with partial thoracic stomach, reduction is achieved by posture whereas elderly people with asymptomatic hiatal herniae seldom need treatment. When symptoms develop or complications appear, reduction of the junction should be seriously considered before the physiological mechanism has suffered irreparable damage. Unnecessary delay increases the risk of stricture formation. The longer the displaced mechanism is exposed to high-pressure jets of reflux from below, the more dilated and atonic the sphincter will be and the wider the hiatus will become. If surgery is going to be done at all it should be done early.

CORRECT DIAGNOSIS

The diagnosis of pathology at the gastro-oesophageal junction presents little difficulty in the majority of cases, but the nature and extent of the lesion sometimes defy even the most careful examination. There is only one safe guide, one key to accurate interpretation—knowledge of the normal. Endoscopy and radiology should therefore be fully utilised.

Endoscopy

Every patient with dysphagia or suspected oesophageal disease should be oesophagoscoped, except if this is anatomically impossible. Unsuspected lesions are often discovered and separate conditions may present at different levels. Negative biopsy reports should not necessarily be regarded as conclusive. It is wise for the surgeon to repeat the endoscopy if this was done previously by someone else. Reports of normality should not always be accepted without qualification.

Radiology

The value of screening cannot be over-emphasised. Familiarity with oesophageal motility and the effect of gravity is essential in order to appreciate neuro-muscular and mechanical derangements of the organ. Identification of the cardia and hiatus is the clue to proper orientation.

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Diagnosis should not be based on inconclusive radiographs, especially not on single films. Repeat examinations can only be an advantage.

ACHALASIA

Achalasia is a condition in which there is (1) loss of oesophageal tone leading to dilatation ; (2) inco-ordinated peristalsis ; (3) hypertonicity of the inferior sphincter, and (4) failure of the sphincter to relax ahead of a contraction. Its exact nature is still unknown. Achalasia-like conditions have been produced experimentally in different animal species and accidentally in man after high bilateral vagotomy. The oesophagus dilates and becomes relatively atonic while the sphincter contracts and shuts the cardia. Not only is ingesta obstructed at the sphincter but all propagated motility is lost. In the erect position gravity will still empty the organ if the hydrostatic pressure overcomes the obstruction, but in the supine position the contents will remain in the oesophagus. Normally this is of little significance but when hydrochloric acid and digestive enzymes remain indefinitely in the squamous-lined oesophagus the danger becomes apparent, The two aims are therefore to relieve obstruction and avoid oesophagitis.

As it is only the sphincter that provides obstruction, only the sphincteric fibres need division. The incision should therefore not exceed 4 to 5 cm. Division of the muscle above and below this level renders the oesophagus more atonic and unnecessarily disturbs the integrity of the folds at the cardia. For the same reason the gastro-oesophageal junction should be handled gently when it is drawn upwards into the chest. The fibres are divided most easily over a thick oesophageal bougie starting at the upper level of the sphincter. The cardia is usually marked by a transverse vein and can be easily recognised. The muscle layers there are thin and most adherent to the mucosa which tears easily. It has been shown that the gap in the muscle six weeks after Heller's operation has been completely bridged by fibrous tissue so that one could hardly demonstrate the site of the incision. I now prefer to excise a longitudinal sliver of muscle 5 mm. wide instead of just separating the layers.

Reflux oesophagitis and stricture do occur after surgery. It is therefore important to disturb the anatomical relationships as little as possible, avoid injury to the vagi and reconstitute a snug hiatus. Surgery is the treatment of choice in the great majority of cases and should be done without preliminary dilatations. Dilatation has a much more adverse effect on the closing mechanism and increases the risk of reflux. When surgery has failed or is contra-indicated bouginage is the treatment of choice.

Achalasia associated with hiatus hernia is serious. It should always be operated upon. The oesophagus is so lax that reduction of the stomach seldom provides any difficulty. The myotomy is done at the same time. Care should be taken not to suture the crura as tightly as in uncomplicated herniae because of the lack of efficient peristalsis.

Gastro-oesophageal anastomosis in achalasia almost invariably leads to oesophagitis, ulceration, haemorrhage and stricture. Where this has to be done in cases of malignancy or stricture with perforation it is better to do a high anastomosis rather than a low one, because the incidence of oesophagitis is lower, the proximal oesophagus usually contracts and therefore empties better, and subsequent dilatation is easier and safer.

GASTRO-OESOPHAGEAL ANASTOMOSIS

Once the closing mechanism has been destroyed its function is lost and resection may be unavoidable. As this mechanism is irreplaceable the aims of surgery should be to prevent the complications as far as possible which necessarily must follow when this protective mechanism is removed. Stricture is usually due to a local recurrence of the neoplasm, a faulty anastomosis, or ulcerating oesophagitis.

The anastomosis

Leaks are not always due to poor technique. Even elderly patients stand oesophageal resection very well provided they are in reasonable general condition and their fluid, electrolyte and protein balance is normal. Although one layer may suffice for the anastomosis, it is wise to relieve the tension on the suture line by hitching the stomach up to the oesophagus or surrounding tissues with a few outer sutures. The inner layer should include bold bites of tissue on each side and mucosal apposition must be perfect. I believe that continuous sutures have a higher incidence of stricture formation. It is a safe precaution to cover the anastomosis with a pleural flap.

Oesophagitis

Evidence strongly suggests that ulceration, oesophagitis and stricture is far less common when the anastomosis is high up in the chest rather than lower down. This may be due to greater resistance of the proximal squamous epithelium to gastric juice, but it is more likely that the biggest pool of gastric secretions would accumulate at the diaphragm and continuously bath the oesophageal mucosa in the low anastomosis. The stomach is mobilised from the abdomen and the anastomosis made above the azygos through a right thoracotomy. Gastric distension and stasis would encourage reflux, the stomach should therefore empty rapidly. The two main sites of obstruction are the hiatus and the vagotomised pylorus. The latter can be overcome by pyloroplasty which is of especial benefit in the low anastomosis. When the hiatus is small and the crura well developed it easily accommodates the oesophagus, but if the stomach with its mesentery and blood vessels is pulled through considerable external compression may result. The blood supply to the supradiaphragmatic portion may even be cut off completely. Undue obstruction

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to the passage of food also would lead to discomfort and even vomiting quite apart from the additional strain on the anastomosis and the increase in reflux. An essential step in the operation is to enlarge the hiatus. This is best done by dividing the anterior hiatal margin between two clamps and then under-running the edges with a thread suture which also secures the anterior phrenic vein.

UNCOMPLICATED HIATAL HERNIA

Not all cases with hiatal hernia should be operated upon, but the displaced and incompetent closing mechanism should always be regarded as a potentially serious condition. Surgery should therefore be considered carefully in each case.

Assessment

The duration and severity of symptoms are most important ; radiographs alone are not an indication for operation. Associated pathology should be excluded or investigated. Hiatus hernia may masquerade as many diseases but it is well to remember that it may also be symptomless. Hiatus hernia may be responsible for peptic ulceration and when it is dealt with the ulcer will disappear. The most important cause for herniation is increased intra-abdominal pressure. To operate on the hernia without eradicating the cause is to jeopardise the repair. Oesophagitis is an absolute indication for operation. It can be established *only* by oesophagoscopy. Medical treatment is often advisable. In obese people weight reduction is essential, even if they have to be admitted to hospital on a 300 to 400 calorie diet. Any drug which abolishes the peristaltic activity of the oesophagus should be avoided, especially at night, for this would deprive the organ of secondary contractions when reflux occurs.

The radiological appearances are valuable not only to decide if operation is necessary but also which type of repair should be carried out. The size of the supra-diaphragmatic loculus and the ease with which it reduces ; the straightness of the gastro-oesophageal junction ; the size of the hiatus and its constrictive action on inspiration ; the length, laxity and width of the oesophagus ; the activity of the sphincter, and incompetence of the closing mechanism should be considered. For example, if the hernia is small, the hiatus narrow and the oesophagus lax, one can be sure of a sound repair and cure of symptoms.

Unnecessary conservatism is then irrational. On the other hand if the hiatus is very wide, the oesophagus relatively short and the patient stocky and obese, a simple repair might not be sufficient and further measures are indicated to ensure that the hernia would not recur.

Principles of repair

A left postero-lateral ninth rib thoracotomy gives adequate exposure and full access to the left diaphragm. Routine incision across the

costal margin is avoided, for these scars tend to be more painful. The thoracic approach is preferred to the abdominal one because extensive mobilisation can be carried out under direct vision with minimum trauma to the tissues. . If the pleura is incised over the stomach loculus just above the diaphragm a natural avascular plane is entered which gives perfect exposure of both crura. The oesophagus is best isolated by following this plane upwards until sufficient mobilisation has been obtained to ensure complete reduction of the closing mechanism to its normal position below the diaphragm. There is only one thing that is going to keep the stomach in the abdomen—the diaphragm, and *the success of hiatal hernia repair depends entirely on how well the crura are approximated.* The fascia and pleura should be left on the crural muscle as they help for the sutures not to tear out. It is most convenient to insert the crural sutures before reducing the hernia while the stomach is lifted upwards with a tape. Deep solid bites of crura should be taken. After reduction of the stomach in the standard way through a small half-inch incision in the diaphragm these sutures are tied so loosely that the crura are only approximated. If they are tied tightly, or even firmly, they are bound to cut through the muscle. If this crucial part of the operation is not well done, all other elaborations of technique are of little avail. Personal feeling is against putting sutures into the terminal oesophagus in order to fix it to the diaphragm, or to create an artificial acute angle. These sutures distort the organ, disturb the normal physiology, tear out easily, and from what has been said before, are of doubtful value.

In the simple easy case the above repair would be quite adequate, but when the hernia is large, the crura poor, and the oesophagus not so lax, additional procedures are necessary. The fundus of the stomach can then be sutured to the undersurface of the diaphragm. This should not be done blindly as it may distort the normal anatomical relationships of the closing mechanism. Also the attenuated phreno-oesophageal membrane can be excised and re-fashioned below the hiatus. If the crura are thin or come together under tension they should not be sutured behind the oesophagus but in front, where the fibres are more tendinous. This can be done only if the oesophagus is very lax because the cardia is displaced even more downwards than normal. When the patient is supine and fully relaxed the diaphragm is high and the reduction might appear easy, but the tension on the oesophagus will be different when the patient is coughing or inspiring in the erect position. If the oesophagus is under tension it is far better to transplant it anteriorly by incising the anterior hiatal margin and suturing the crura behind. At the same time part of the left diaphragm can be elevated by cutting across the dome or preferably by selectively paralysing the anterior and lateral branches of the phrenic nerve but preserving the postero-medial branch to the crural muscle.

Surgery of the oesophagus is not always easy ; it is often disappointing. Success and failure walk side by side in the practice of every surgeon.

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Only with full understanding of the underlying mechanisms, care ul assessment of clinical material and meticulous attention to surgi al detail can we attempt to improve our results.

ACKNOWLEDGMENTS

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COUNCIL ELECTION 1959

ON THURSDAY, 2ND JULY, Mr. R. V. Cooke and Mr. H. Osmond-Clarke, C.B.E., were elected Members of the Council of the College.

The result of the poll was as follows :

Elected	Votes
Mr. R. V. Cooke (Bristol Royal Hospital)	718
Mr. H. Osmond-Clarke, C.B.E. (The London Hospital)	675
Not elected	
Mr. A. H. Whyte, D.S.O., T.D. (Royal Victoria Hospital, Newcastle-upon-Tyne)	406
Mr. H. Jackson (National Hospital for Nervous Diseases)	334
Mr. L. N. Pyrah (Leeds General Infirmary)	397
Mr. D. Ioan-Jones (Cardiff Royal Infirmary)	119
Mr. N. R. Barrett (St. Thomas's Hospital)	550
Mr. E. G. Muir (King's College Hospital)	534
Mr. H. W. Rodgers, O.B.E. (Royal Victoria Hospital, Belfast)	267
Mr. V. H. Riddell (St. George's Hospital)	365
Mr. G. Qvist (Royal Free Hospital)	239

In all 2,455 Fellows voted, and in addition 40 votes were found to be invalid and 141 arrived too late.

THE SURGICAL TREATMENT OF NASAL SPEECH DISORDERS

Hunterian Lecture delivered at the Royal College of Surgeons of England

on

29th January 1959

by

James S. Calnan, F.R.C.S.(Ed.), M.R.C.P., L.D.S.R.C.S.

WE ARE CONCERNED, in this lecture, with such disorders of speech as are associated with nasal escape and which have, over a number of years, become recognised as within the province of surgery. It is proposed first to consider the essential differences between normal and nasal speech, to discuss physiological mechanisms, and finally to consider surgical therapy in the light of these findings.

Normal speech

In normal speech we have an assortment of fixed sounds called phonemes, some of which are differentiated by the larynx into voiced and unvoiced elements, according to the presence or absence of the laryngeal vibrations. If the flow of expired air passes freely across the resonators of the oro-pharynx and mouth, the sounds so formed are called vowels. On the other hand, if the flow of laryngeal air is impeded or checked in any part of the buccal cavity, the sounds thus made are known as consonants. In the English language only three consonants M (*m*) and N (*n*) and (n) (the sound " NG ") are made with a nasal intonation by allowing some air to escape up behind the soft palate into the nose. All other sounds demand that the nose should be shut off from the mouth during their production. This simplified phonetic description will serve as an introduction to the subject, so let us now consider what happens to the individual who is unable to close off his nose from his mouth.

Nasal speech

The effects on speech of an incompetent mechanism for closure of the nasopharynx may be listed briefly into primary faults and secondary faults. The primary (i.e. dependent essentially on an incompetent nasopharyngeal mechanism) are :

(1) Weak pressure for all vowels and consonants.

(2) Lack of clarity of articulation—i.e. a lack of crispness.

(3) Lack of adequate voice projection.

(4) Nasal escape of air, and frequently a nasal breath sound or whistle when the nasal septum is deflected.

(5) Excessive nasal resonance.

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The secondary (as a result of certain adjustments to the disabilit) faults are :

(1) Glottal stop sounds are substituted for P, T, K, B, D, and G, because the necessary air pressure for the production of these plosive sounds cannot be built up or maintained in the mouth. The sound is therefore made further back, in the larynx.

(2) Pharyngeal fricative sounds replace the consonants S, Z, Sh, Zh, and sometimes Ch and J, for similar reasons.

(3) Articulatory insufficiency ; by that I mean a type of articulation due to insufficient use of the tongue, lips and jaws.

(4) Unintelligible vocalisation, such as a snort.

(5) Harshness of voice due to attempts to overcome the effects of excessive nasal resonance.

(6) Nasal grimace.

(7) Breathlessness during conversation.

When most of these faults are present that person is said to have cleft palate speech. This term is not a good one, for, as will be shown later, this type of speech may occur in a person who has no cleft palate and who indeed may have a normal palate. In using this term one may be manoeuvred into the foolish position of having to say that a patient has " cleft palate speech without cleft palate ".

For the purpose of studying its effect on speech, nasal escape may be produced experimentally by passing a firm rubber tube down one nostril into the pharynx. In this way the resultant disability from an air-leak may be observed by the volunteer and listener alike. It may also be studied in children and adults with congenital cleft palate or other defects of the palato-pharyngeal mechanism.

Nasal escape may be present from the beginning, so that the development of normal speech is prevented. In such cases severe disturbances of articulation are commonly found. Nasal escape may also occur after the development of normal speech. If the onset is gradual the effect on articulation is minimal : there may be some lack of clarity and poor voice projection and tone, but little disturbance of the vowels and consonants. Such an event may occur in the normal and in cleft palate patients in adolescence. When, however, the onset of nasal escape has been sudden, such as may occur after the surgical removal of adenoid tissue, more severe disturbances in speech associated with considerable emotional upsets are encountered.

Closure of the Nasopharynx

So far I have suggested that the development of normal speech depends on a competent mechanism for closing the nasopharynx, and so we may ask " How is this done ? ". Gustav Passavant, a surgeon in Frankfurt, in 1869 suggested that when the soft palate was elevated a projection of

the posterior pharyngeal wall came forward to meet it, thus shutting off the nose from the mouth. This forward projection from the posterior pharyngeal wall was thought by Passavant to be due to specialized fibres of the superior constrictor muscle. These fibres incidentally were rediscovered by the French anatomist Sappey some fifteen years later, and also by Professor Whillis in 1930, who named them the " Palato-pharyngeal sphincter". The forward projection of the posterior-pharyngeal wall has subsequently become known as " Passavant's ridge " and has provided much material for argument among anatomists and surgeons alike—the anatomists basing their arguments on careful dissections of patients in whom this phenomenon was not known to have occurred during life, the surgeons basing theirs mainly on extreme conservatism and on great faith. This is not sophistry for two previous Hunterian professors, both great exponents of Passavant's theory of nasopharyngeal closure, expressed their firm belief in this projection, yet both produced lateral X-rays of the nasopharyngeal area of patients and normal adults during phonation and in *none* of these photographs was a Passavant's ridge to be seen !

To believe in a phenomenon which is not there I consider to be great faith and it was this sort of faith which led many surgeons between the two World Wars to put forward theories concerning the methods of production of Passavant's ridge. Even in 1869 there were many good armchair reasons for doubting Passavant's theory of closure of the naso-pharynx, but because these doubts were not voiced at the time the theory crept into current surgical thought ; and, like so many other surgical doctrines, it requires a lot of work to get rid of them. With the introduction at Oxford of a relatively easy and reliable method of taking radiographs of the palato-pharyngeal region (Calnan 1952, 1956) it has been possible to collect X-ray films of a representative series of patients. Passavant's ridge was observed in only sixty-one persons of 265 examined and occurred in less than a quarter of any particular group of normal and abnormal speakers. Whereas if it was the normal event we should expect to find it in at least 75 per cent. of all cases. Indeed it is found nearly three times as commonly in persons who have an incompetent palato-pharyngeal mechanism than in those who have a competent one (Table I).

TABLE I

PASSAVANT'S RIDGE

RELATIONSHIP TO COMPETENCE OF THE PALATO-PHARYNGEAL MECHANISM

61 CASES

Palato-Pharyngeal Mechanism	Passavant's Ridge seen on X-rays	Incidence
Incompetent	47	77%
Competent	14	23%

Hypothesis concerning closure of the nasopharynx.

I should like now to define a hypothesis concerning closure of the nasopharynx during speech, and in more precise terms to advance proof and counter-proof in its favour, and finally to make deductions which have a direct bearing on the treatment of various speech disorders associated with nasal escape. The hypothesis of palato-pharyngeal closure is based on observations of normal and abnormal speakers. Twelve observations have been made direct via suitable facial fistulae, but the majority have been made indirectly using lateral radiography in some 400 persons.

1. The soft palate at rest lies in a relaxed position on the dorsum of the tongue. This is contrary to what one finds in anatomy books where the soft palate is shown hanging in a mid-position in the oropharynx.

2. The soft palate in contact with the tongue and by virtue of its depressor muscles maintains closure, in other words competency, of the oropharyngeal isthmus during nasal breathing, on blowing the nose, and during mastication.

3. During speech the anterior $\frac{2}{3}$ to $\frac{3}{4}$ of the soft palate elevates to reduce the size of the nasopharyngeal opening (Fig. 1). The posterior

LANDMARKS (PHYSIOLOGY)
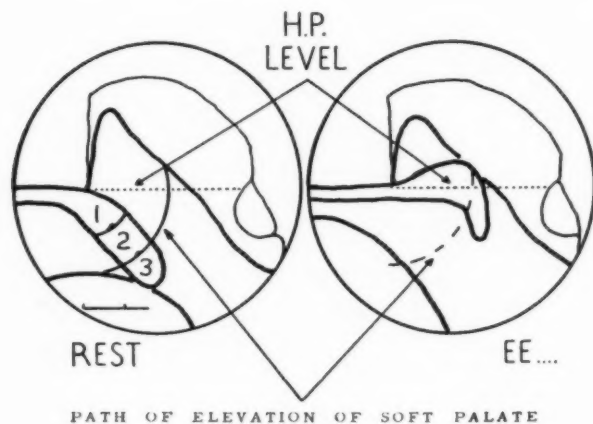

PATH OF ELEVATION OF SOFT PALATE
Fig. 1

third of the soft palate, including the uvula, remains dependent or slightly antiflexed during this elevation and is not in contact with the posterior pharyngeal wall.

4. During elevation a levator eminence is formed on the nasal surface of the soft palate due to a bunching up of the active levator palati and the relaxed palato-pharyngei muscles.

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5. During the production of non-nasal speech sounds, the soft palate elevates to above the level of the hard palate and makes contact with the posterior pharyngeal wall.

6. Synchronous with the elevation of the soft palate there is some medial movement of the lateral pharyngeal walls due to the muscles contained therein, but this movement is of no great magnitude.

7. Synchronous forward movement of the posterior pharyngeal wall is negligible during speech. Passavant's ridge (so frequently absent) does not play an essental part in normal nasopharyngeal closure (Calnan, 1954,1957).

8. During nasalized speech sounds, the soft palate does not elevate to such a high level, and there is a gap between the elevated soft palate and the posterior pharyngeal wall.

9. Since the soft palate is attached to the posterior border of the hard palate, and the magnitude of its elevation is fixed within certain limits by virtue of the action of its muscles, the point of contact of the soft palate with the posterior pharyngeal wall is determined by the relationship of the hard palate to the bony structures of the posterior pharyngeal wall (Fig. 2). In infancy the hard palate is level with the basi-sphenoid, but
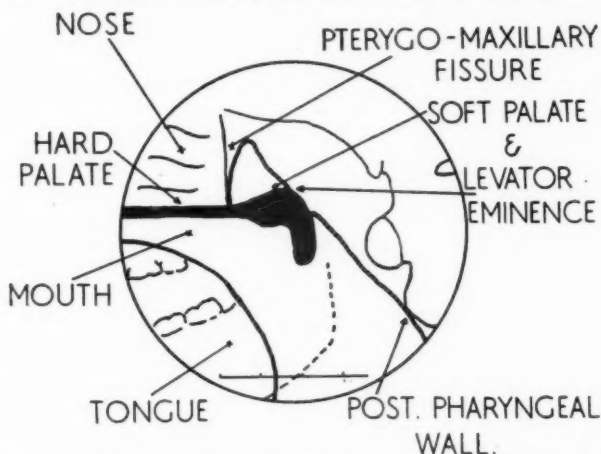

Fig. 2. Landmarks (Anatomy). Lateral X-Ray of Palate and Pharynx. Patient saying " EE . . . " (i).

it descends during growth to come to lie opposite the anterior tubercle of the arch of the Atlas in adult life (Brodie 1941).

10. Adenoid tissue present on the posterior pharyngeal wall may be interposed between the elevated soft palate and the posterior pharyngeal wall, and to a greater or lesser degree interfere with the normal point of contact between them. Adenoid tissue may also limit the normal range

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of elevation of the soft palate (Subtelny and Baker 1956 ; Calnan 19:4, 1956).

11. Closure of the nasopharynx by a competent palato-pharyngeal mechanism is essential for the development of normal speech.

Now a hypothesis is a tentative explanation of certain observed facts, and the four requisites of a good hypothesis are (Trelease 1958) :

1. It should explain facts that have not hitherto been adequately explained.

2. It should be consistent with all the known facts.

3. It should be no more complex than necessary to account for the phenomena, while aiding the prediction of new facts and relations.

4. It should be susceptible of verification or refutation.

Proof and counter-proof for the hypothesis

In law, proof is required " beyond reasonable doubt ". In science, this is not sufficient. According to Claude Bernard proof is always required to establish a hypothesis, and counter-proof is also necessary to carry philosophic doubt as far as possible. " Counter-proof decides whether the relation of cause to effect that we seek has been found ". One experiment, as I have said, is to pass a catheter down one nostril, thereby establishing an air-leak into the nose and observe the effect on speech. Another method is to remove a portion of the posterior pharyngeal wall at its site of contact with the elevated soft palate leaving an appreciable and measurable gap. As such, this would be an immoral experiment, but fortunately tissue forming the posterior wall of the pharynx, the adenoid mass, may be removed by a laryngologist on occasion with just the result required for our experiment.

Experiment

C.M. aged thirteen had spoken normally until eighteen months ago when her tonsils and adenoids were removed for recurrent head colds. Since that time speech has been muffled, indistinct, characterized by obvious nasal escape and lack of voice projection, and she used to get out of breath at the end of long sentences. In the past year her standard of attainments at school had fallen below that of her associates and she had become introspective and shy. Regurgitation of fluids down the nose occurred for the first month after operation. On examination, articulation was found to be correctly positioned but with accompanying nasal escape, assessed as " medium " in quantity. Radiologically there was a gap of 5 mm. between the normally elevated soft palate and the pharynx on saying " EF . . ." (Fig. 3). The pharyngeal isthmus measured 31 mm. wide from a mould made at the time of treatment. The intelligence quotient was 102 and the reading age estimated at twelve years, although a precise estimate of reading ability was not possible on account of the difficulty in pronunciation caused by her speech defect. In September 1957, a full-thickness costal cartilage with its perichondrium, 32 mm. long and 11 mm. wide and 8 mm. thick was implanted behind the posterior wall of the pharynx at a level above the arch of the Atlas. It was fixed to the anterior common ligament by a fine stainless steel suture and the horizontal wound closed in the pharynx.
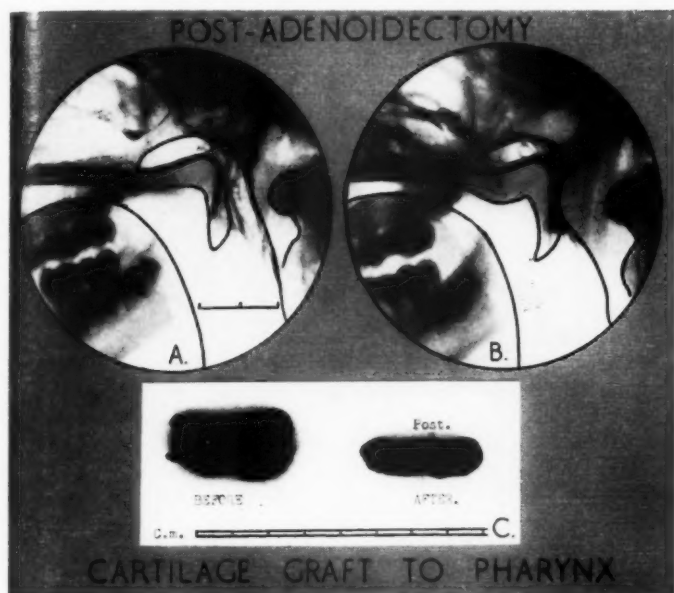
Fig. 3

Moulds made before and after operation, while under the anaesthetic, demonstrate that while the depth of the isthmus has been altered the width has remained the same. X-rays taken one week after operation confirmed the palato-pharyngeal competence. At that time speech was reassessed and found to be normal and has been for a year since. There was no longer any nasal escape by the mirror test. The normality was recognised by her mother, a very important critic in this type of experiment.

Nasal speech, consequent on removal of the adenoid pad, in a patient with a normally elevating palate is interpreted as *proof* that a competent palato-pharyngeal mechanism is necessary for normal speech. Counter-proof was supplied by replacing the necessary bulk in an anterior-posterior direction only, in the nasopharynx, to restore speech to normal. This experiment has been repeated on six further occasions with the same result.

Methods available in investigation of nasal speech defects

In investigating persons with nasal speech we require to know a good deal about the speech, the soft palate and pharynx, tongue and lip movements, the hearing, the personality, and the I.Q. In the same way that the Chest Physician no longer makes a diagnosis of a lung condition without an X-ray (indeed, he frequently studies the X-ray before seeing the patient), so too in treating speech disorders we must place great

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reliance on this investigation. A simple lateral X-ray will give us much of the information that we require. If, however, we wish to study movements, then ciné-radiography is essential. If, on the other hand, we wish to make accurate measurements of the parts to observe their growth or their angular relationships one to another, then we use cephalometric radiography (Broadbent, 1931).

Causes of nasal escape

It is relevant here to consider the possible causes of nasal escape (Calnan, 1957).

A classification can be made from known and deduced conditions from what has already been said concerning the hypothesis of closure of the naso-pharynx. We can in fact divide patients into three categories depending on the condition of the soft palate (Table II). In the first, the soft palate is *anatomically* abnormal because it is cleft. In the second group the soft palate is *functionally* abnormal because it is paralysed, while in the third group the soft palate is *essentially* normal. Under these three main headings one can place many other known conditions causing nasal speech. Let us consider the commonest condition—cleft palate.

TABLE II

CAUSES OF NASAL ESCAPE DURING SPEECH

A. ANATOMICAL DEFECTS OF PARTS (Defects of mechanics) :

    1. *Congenital* : Cleft palate.
                  Submucous cleft palate.
                  Absence of portion of soft palate or pillars of fauces.

    2. *Acquired* : Trauma—surgical, gun-shot wounds.
                  Disease—cancer, lues.

B. DEFECTIVE MOTOR POWER (Defects of Dynamics) :

    1. *Neurological :*

        (a) Nuclear and peripheral
            Congenital : Nuclear hypoplasia
            Acquired : Trauma. Disease—diphtheria, poliomyelitis.
        (b) Supranuclear
            Congenital paresis
            Encephalitis, meningitis.
        (c) Cortical
            Gross mental deficiency. Hysteria.

    2. *Muscular :*
        Congenital agenesia, unilateral or bilateral.
        Scar tissue.

C. DISPROPORTION OF PALATE AND PHARYNX (Defects of Kinetics) :

    1. *Congenital* : Repaired cleft palate.
                  Congenital short palate.
                  Congenital large pharynx.

    2. *Acquired* : Post-adenoidectomy.

Cleft palate

In order to estimate the efficiency of modern surgical methods in the treatment of cleft palate, 245 cases were studied. All patients had had

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their operation before the age of two years and all have been assessed independently by speech therapists with the following standards : the presence of nasal escape was estimated on average by a mirror held beneath the nostrils during the six vowels (and especially important is the assessment on " EE " and " OO " in which the soft palate has the highest elevation) and during consonants. Articulation was passed as normal if all individual consonants were correctly placed and acoustically correct. The operations were carried out by three surgeons during a nine-year period and final speech assessments were made after the age of five years.

The type of cleft had quite a marked influence on the speech result, for the type of surgical repair had been the same in each case (Kilner, 1937). The distribution of the various types of cleft in this sample of 245 cases was compared with the 500 cases recorded by Veau in 1931 and 412 by Oldfield in 1947. The proportionate distributions were found to agree quite well : we may thus presume that our 245 cases are a representative sample of the cleft palate population.

If we now scramble the results and express them in the form shown in Figure 4, one can say with some confidence : " Do this operation (the
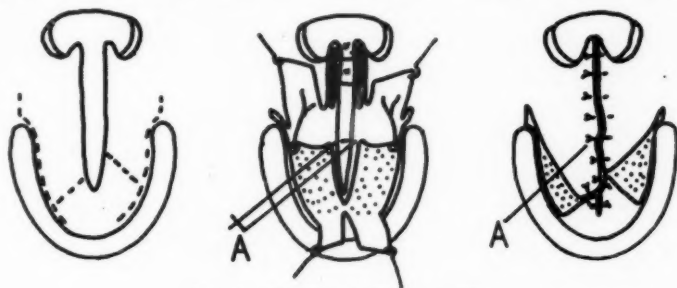

Fig. 4. V-Y Repair (Kilner 1937)
Speech results after V-Y operation
75.5% with normal articulation ± standard error 2.74.   1.2% major breakdown.
64.1% with no nasal escape ± standard error 3.06.   11.4% minor breakdown.

Kilner V-Y repair) and you will get this sort of result ". Mr. J. P. Reidy in a Hunterian lecture (1957) found 77 per cent. of his patients had normal articulation—a figure well within the range indicated here by the 95 per cent. fiducial limits (± two standard errors) of this statistical assessment.

Experience in V-Y repair

In order to estimate the influence of " experience " as opposed to " training ", cases treated by trainee surgeons were assessed. Of thirteen cases, 69 per cent. obtained no nasal escape after the development of speech and 69 per cent. had normal articulation : results similar to those

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already shown.   This after all is rather what we might expect, for opera ive techniques which require experience for their successful conclusion are usually bad.

Formula for speech result after palate repair

The result of operation for cleft palate in the infant seems to depend on a simple algebraic formula :

Surgeon + operation + age + X = speech result.

Thus in an infant—

$$S + O^\kappa + A_2 + X = R \text{ (See Fig. 4)}.$$

and in adult cleft palate patients—

$$S + O^\kappa + A_{18} \text{ (or over)} + X = R_1$$

In the infant S, surgeon : O, operation : and A, age are constants or nearly so.   The speech result depends on X which consists of controllable and uncontrollable variables : the controllable include freedom from infection and adequate nutrition, good conditions for operation and after-care ; there is also a small element of " luck " which enters into every surgical operation and which our older brethen used to call the " art ". As we have become more scientific and less artful, this last factor has decreased in significance.

The bihamular width

So far so good, but in 1928 Lexer in Germany and Wardill in this country suggested that in cleft palate the pharynx was *wider* than normal— a possible explanation for the 25 per cent. of the infants treated who failed to obtain normal speech.

The 1928 modification in our formula thus becomes :

Surgeon + operation + age + X + narrow pharynx
                              = speech result.

$$S + O + A_2 + X + Ph = R.$$

Wardill (1928) measured the bihamular widths in sixteen cleft palate skulls and concluded that—" in cleft palate there is a definite bony increase in the transverse diameter of the nasopharynx.   The increase is expressed only in terms of millimetres, and as such appears extraordinarily small in amount.   But, as I have attempted to point out, the naso-pharyngeal valve is of such precision and delicacy that even a minute change in its diameter will cause disastrous interference with its competence. How far these results are applicable to the living subject it is difficult to say.   Moreover, the differences met with in cleft palate subjects vary in the extreme."

Based on this cautious assessment Wardill devised an operation to narrow the width of the pharynx.   In 1933, five years later and without

producing any new evidence, Wardill was able to write—" In cleft palate there is a *marked* increase in the bony diameters of the nasopharynx, and any operation designed to restore the pharyngeal valve must take account of this, otherwise the palate might be repaired with the best possible aesthetic result yet no closure of the palato-pharyngeal valve attained. "

Now there are three unusual things about the table presented by Wardill for there is—

1. No indication of the *type* of cleft palate of any of the skulls measured.

2. No mention or estimation of the *age*.

3. No indication whether the bihamular width was measured from the tips of the processes or from their bases.

Comparison measurements made with individual normal skulls, even twenty years ago , was pretty dangerous practice. Moreover, there is no indication of what the normal measurements might be at various ages.

Now, Wardill and others have concluded that the bihamular measurement represents the width of the pharanx at that level. Anatomy books suggest this in their diagrams. In a transverse section from *The Detailed Atlas of the Head and Neck* by Truex and Kellner (1948), a picture rather frightening in its detail, a close look shows that the hamular processes appear to be in the same plane as the lateral margins of the nasopharynx.

But we can do better than this. By measuring the bihamular width and by taking a mould of the nasopharynx on patients at the time of operation, we can obtain two sets of figures for comparison. From Figure 5 one may see that the width of the nasopharynx agrees very well

P.P., female aged 15 - 6

Fig. 5.   Premise: Bihamular width = width of nasopharyngeal isthmus.
15 PATIENTS.
VARIOUS AGES.

Bihamular Width (measured)	Width of Nasopharyngeal Isthmus (mould)
Mean = 30.93 mm.	Mean = 31.66 mm.
S.D. 3.53	S.D. 4.61
S.E. 0.915	S.E 1.19

As a quick test of the validity of these figures we can assess the bihamular width of the most expensive skulls in this College, Hunter's giants, to find that they are 32 mm. and 34.5 mm. Measurements on the unique collection of foetal skulls in the Hunterian Museum (Table III) outlined

TABLE III
BIHAMULAR MEASUREMENTS
FOETAL SKULLS (NORMAL)

Age	Number of skulls examined	Mean in mm.	S.D.
5 months	4	7.2	0.85
5.6 ,,	6	9.0	1.45
6 ,,	6	11.5	1.04
7 ,,	7	13.4	0.57
8 ,,	6	15.0	0.24
9 ,,	17	16.5	1.67
Birth			

clearly the progress of intra-uterine development, while measurement on some eighty immature skulls has provided information about the growth of the bihamular width and given standards of the normal for various ages. They suggest that this dimension ceases to grow after the eruption of the second upper molar tooth and before the eruption of the third molar (Ford, 1958). Unfortunately it is not possible to be more precise. The number of the cleft palate skulls in the country is rather limited but it was possible to find and measure seven adult and seven new-born skulls; six adult skulls had mild post-alveolar clefts of the hard palate and only one skull had a bilateral complete alveolar cleft (Group III.3). They are therefore not good representatives of the varieties of cleft palate that may be encountered in clinical practice. In the adults (and I have included measurements from moulds made of the pharynx in adult cleft palate patients) the mean measurement differs little from normal, but the standard deviation (an expression of the range) is more than twice as large (Table IV). This indication, that there is a much wider range in

TABLE IV
THE BIHAMULAR WIDTH
CLEFT PALATE

	Total	Mean in mm.	S.D.	S.E.
Adult skulls	7	31.57	2.13	0.87
Adult moulds	14	31.00	8.16	2.26
Totals	21	31.19	6.57	1.43
Normal skulls	205	30.73	2.89	0.202

cleft palate than in the normal, implies too that the adult cleft palate patient belongs to a different population. We may therefore conclude

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that although the bihamular measurement in a particular case of cleft palate may be wider than normal, a little less than half come within the normal range.

One may therefore conclude that the bihamular width does reflect the width of the nasopharynx at the level of the isthmus. We are now in a position to qualify the generality of Wardill's hypothesis although we have not yet explained why some infants have nasal speech after an apparently successful operation.

Cause of nasal speech after palate repair

To try and answer this question sixty-six patients were investigated. All had had a V-Y repair for cleft palate before the age of two years and were now aged five to twenty years : thirty-eight had normal speech and twenty-eight had nasal speech. In the past many surgeons have felt that poor surgical results were due to poor mobility of the soft palate : this may be so, but in these two groups examined there was little difference between them.

Does the difference between normal and nasal speech depend then on the length of the soft palate, or on the depth of the pharynx ?

The sample of sixty-six patients falls into six different age groups and would require many tables to answer these questions. Fortunately we can use a simple trick to obtain a bird's-eye view of the position—that is by comparing the effective length of the soft palate with its total length, and by comparing the depth of the soft tissue pharynx with the total length of the soft palate : i.e. the divisor is the same for each individual and the result can be expressed as a percentage. Moreover, the percentages can be totted up and presented as a mean for each group, for it has been found that in the normal both measurements fall within the narrow limits of 65 to 75 per cent. at all ages (Subtelny, 1957).

Anatomical proportions	38 Non-nasal speakers	28 Nasal speakers
$\dfrac{\text{Effective length soft palate}}{\text{Total length of soft palate}} = \%$	61.2%	61.4%
$\dfrac{\text{Depth of soft tissue pharynx}}{\text{Total length of soft palate}} = \%$	58.5%	73.8%

This shows the result of such mathematical magic and also demonstrates that it is the pharynx which is relatively too deep for the soft palate to occlude in the nasal speech group. It should be remembered that in cleft palate total length and effective length of the soft palate are both shorter than in the normal.

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Adult cleft palate

So far we have dealt with cleft palate repaired before the age of two years. How then does age at operation affect the result as judged by speech? The graph in Figure 7 shows that while about 75 per cent. of
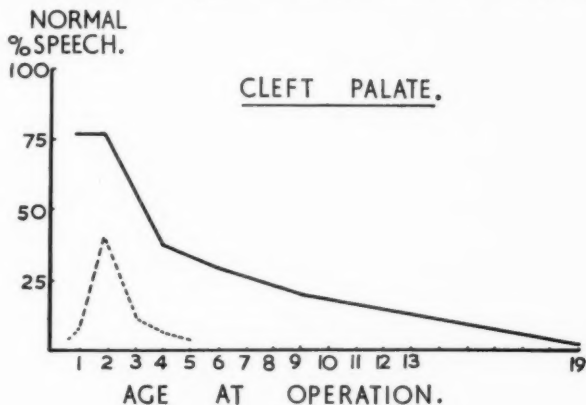
NORMAL
% SPEECH.

CLEFT PALATE.

AGE AT OPERATION.

Fig. 7.

infants speak with no excessive nasal escape after operation, nearly all adults do so. Why is this?

In those infants who fail to obtain normal speech after early operation it has been suggested that it is the pharynx which is primarily at fault. This is probably so, for it would seem that the tissue deficient is the adenoid vegetation, for the bony structures, over which the soft tissues of the naso-pharynx are draped, are essentially normal in their inter-relationships.

In the adult patient the position is somewhat different. Thirty-three patients were studied before and after operation and in seventeen full radiological investigations were made. This seems rather a small sample from which to generalize, but adults with unrepaired cleft are rare birds these days, even in Oxford. With the aid of a few statistical methods we can reach reasonable conclusions and not be unduly worried by the thin-lipped smile of the critic with a contempt for small samples.

When these seventeen are compared with thirty-one normals we find that the total length of the soft palate and its effective length in cleft palate are much below normal. The depth of the soft tissue pharynx and the depth of the bony pharynx are both within normal limits. In comparing the mobility of the soft palate, the adult cleft palate is on average a little less mobile than normal, The gap between the elevated soft palate and the posterior pharyngeal wall centres about a mean of 7 mm., whereas in the normal the mean is less than 1 mm. In fact quoting a " mean " for the normal gives a quite erroneous impression, for 75 per cent. of normal people have no gap at all !

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In the adult cleft, as opposed to the infant cleft, we have perforce to treat the pharynx by bringing its posterior wall forward—in every case—for the speech results indicate that repair of the palate alone will not eliminate nasal escape.

Paralysis of the soft palate

What has been learnt from this detailed study of the physiology of normal and cleft palate patients may now be applied to other disorders where nasal speech is a feature.

Where the soft palate is paralysed, due to an upper or a lower motor neurone type of lesion, congenital or acquired, the results of treatment are extremely poor. If the soft palate is long enough to suture to the posterior pharyngeal wall it is possible in this way to close off three-quarters of the post-nasal airway. To close this passage completely would produce unpleasant symptoms of nasal obstruction and unpleasant speech : unfortunately leaving even a small opening creates an air leak which is not under the patient's control. If the soft palate is short or the pharynx deep a Rosenthal (1924) pharyngoplasty is all one can offer. I have never heard normal speech after this operation. Prosthetics has little to offer either, for the fitting of an obturator is so hampered by the immobile dependent soft palate that few patients can even tolerate it.

However, the diagnosis of " paralysed palate " should never be made until full investigations have been carried out including still and ciné X-rays, and faradic stimulation of the soft palate under a light general anaesthetic. One has encountered such patients like an eight-year-old boy seen recently, who had spoken with nasal escape from early days. On X-ray his soft palate remained depressed on saying " EE . . ." but elevated quite normally on blowing. This is difficult to explain physiologically unless one postulates an unusual supranuclear lesion. On taking further X-rays, saying " Ah " and " OO . . .", it was noted that the soft palate could elevate normally and was competent. Hence one was forced to conclude that this was a cortical lesion—either hysteria or malingering. Such investigations may not make treatment of the patient any easier, but they serve to keep the surgeon's fingers in his pockets and his reputation intact.

Congenital large pharynx

There is another condition, and not uncommon, where speech has been nasal from infancy and where there is no cleft palate. Because of these unusual findings the palate is often said to be paralysed and the patient referred for speech therapy. Of the thirty-odd cases seen at Oxford about half had had speech therapy regularly prior to investigation, once a week, for anything up to ten years without improvement. This is an unsatisfactory state of affairs because surgical treatment can, and usually does, procure immediate and dramatic cure.

Now the palate was suspected to be paralysed in nearly a quarter of these cases—but in none was this really so. The gap between elevated soft palate and pharynx, however, varied from 2 mm. to 12 mm. with a mean measurement of 8 mm. The total length of the soft palate was usually normal and the effective length nearly so. The pharynx however was invariably deeper than normal for the age, and frequently wider than that of a normal adult. Adenoid vegetations were rarely encountered at any age. Most patients showed two other interesting features. (1) A lack of facial expression and a rather weak smile which are almost diagnostic of the syndrome. Both appear to become normal after the eradication of nasal escape—a fact exceedingly difficult to explain. (2) Diminished innate intelligence. The average I.Q. in twenty-two cases was eighty-five, with a range from sixty-five to 110, while educationally they were, on average, thirty-two months behind their fellows. It has long been known that reading ability is intimately associated with speech and hence it is not surprising that the group as a whole was nearly two years retarded in reading age.

When patients with this condition were first seen, the diagnosis of " congenital short palate " was made. Such a syndrome is mentioned in many textbooks although usually inadequately described. As a result six patients were treated by a V-Y retroposition of the soft palate, without improvement. The condition was therefore studied in greater detail and relabelled " congenital large pharynx "—a term suggested by Professor Kilner. This descriptive term has been retained, although " congenital palato-pharyngeal disproportion " is more accurate because, in addition, the soft palate may be shorter than normal in some cases.

Once diagnosis has been accurately made, treatment of the speech defect may present little difficulty. If the posterior pharyngeal wall is brought forward at the right level and by the correct amount, the normally mobile soft palate may thereby close off the nasopharyngeal isthmus during speech. Nasal escape is eliminated and since the articulation is frequently positionally correct, normal speech ensues. Thus surgical success is often dramatic and satisfying. Furthermore the operation can be repeated if an error of calculation has been made. Of the eighteen cases treated so far, eight have been treated by the pharyngoplasty devised by Wilfred Hynes of Sheffield (1950, 1953), while ten have had costal cartilage implanted behind the posterior pharyngeal wall.

The Hynes pharyngoplasty is a very efficient operation for it does what its originator intended—it narrows the width of the nasopharynx effectively and permanently. The prominence produced on the posterior pharyngeal wall averages 6 to 7 mm. and on the whole this too is permanent, although in some cases it may shrink considerably. The latter finding is reflected in the standard deviation which varied from 1.75 to 2.35 according to the time after operation when the radiographic measurements were made.

The results of treatment of cases of congenital large pharynx are simi ar to those for all other patients treated by these two methods and so ve may examine a larger series in order to reach some conclusions on th ir comparative merits. Since cases were not randomized this is not an accurate way of comparing two surgical techniques. However, it is he best one can do for the present. Fortunately the cases are compara ble with regard to width, depth and area of the nasopharyngeal isthmu,— as indicated in the top right-hand corner of Figure 8.

HYNES PHARYNGOPLASTY V. CARTILAGE IMPLANT

CASES.

HYNES PHARYNGOPLASTY   28

CARTILAGE IMPLANT   23

WIDTH OF PHARYNX   33
                            34
DEPTH OF PHARYNX   20
                            19
AREA OF ISTHMUS

ANATOMICAL RESULTS

DIFFERENCES: BEFORE-AFTER

	WIDTH (mm)	DEPTH (mm)	AREA (sq. ins.)
HYNES PHARYNGOPLASTY	16·46	10·44	O·56
CARTILAGE IMPLANT	5·75	6·94	O·37

Fig. 8.

We are of course comparing different physiological concepts: in one the intent is to reduce the pharynx in width and depth, in the other reduction in depth only is attempted.

These measurements are based on moulds made of the nasopharynx before and after operation, under the same general anaesthetic. From the table in Figure 8 it will be seen that the Hynes operation, on average, reduced the width of the pharynx by 16 mm., the depth by 10 mm. and the area of the isthmus by one-half square inches. The comparable figures for the cartilage implant cases are 5 mm., 6 mm., and one-third square inches. The reduction in diameter of the width of the pharynx is nearly three times more effective by the Hynes operation than by the cartilage implant operation.

Now if we look at the speech results (Table V) we find that articulation and elimination of nasal escape, expressed as percentages of the cases treated, are about the same in the two groups. The nasal resonances, however, are quite different. After the Hynes operation about one third have normal resonance, a third have diminished resonance and a third

TABLE V

HYNES PHARYNGOPLASTY AND CARTILAGE IMPLANT
COMPARISON OF SPEECH RESULTS IN 51 CASES

Operation	% With no nasal escape	% With correct articulation	Resonance (as % total)		
			Normal	Diminished	Excessive
Hynes Pharyngoplasty 28 cases	46	71	43	36	21
Cartilage Implant 23 Cases	57	78	74	8.7	17.3

still have excessive nasal resonance.   Whereas after the cartilage implant operation 74 per cent. have normal resonance.   From this one may deduce that reduction in the width (and area ?) of the pharynx may be acoustically undesirable.   (And see section on bihamular width in the normal.)

Nasal resonance and nasal escape

Excessive nasal resonance after operation is a sign of failure, for it can be shown that this type of resonance is related directly to the amount of nasal escape of air during speech. Renfrew (1959), has recently shown the association between the two : the amount of excessive nasal resonance (as judged by the listening ear) increases directly with the amount of nasal escape (as measured on a cold mirror held beneath the nostrils). The associations were based on nearly 500 assessments and so are likely to be representative. If excessive nasal resonance is plotted against the gap between the elevated soft palate and pharynx as seen on X-ray, a similar association is seen—very much as one would expect.

Post-adenoidectomy nasal speech

This last association leads me to discuss one type of speech disorder which was predicted some years ago, when the functional anatomy of the palato-pharyngeal mechanism was being studied. Nasal speech, sometimes of distressing intensity, may ensue after removal of the adenoid vegetations. It is difficult to discover just how frequently this disaster occurs but Gibb (1958) in Scotland, and my own experiences in Oxford, suggest that it occurs often enough to warrant further study and the search for a remedy.   There are two unusual features in the iatrogenic complaint. The first concerns the E.N.T. surgeon responsible, for the adenoids may have been removed as an " encore " after tonsillectomy, in which case he may entertain a feeling of guilt regarding the altered speech.   Or more unfortunately, the adenoids may have been removed because of nasal speech, the laryngologist mistaking the sound of nasal escape for that of diminished nasal resonance. Twenty per cent. of those cases that have been described as " congenital large pharynx," and where nasal escape was already established, had had an adenoidectomy carried out for this with

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unfortunate results. One good indication for adenoidectomy is the p es-
ence of deafness of the obstructive and intermittent type. This is an
indication even in cases of cleft palate where it may already be known
that the normal speech, which developed after repair of the cleft, depends
on the presence of a large adenoid pad. An alternative treatment is to
leave the central mass of the vegetations alone and curette those around
the Eustachian orifices, but this limited removal may fail to clear the
attendant infection and so may fail to improve the hearing.

There are many other reasons for adenoidectomy, some of them little
related to logic or scientific twentieth century medicine. Morris (1957)
an epidemiologist, has investigated what he has called the " Glover "
phenomenon : the unexplained fact that the numbers of children requiring
adenoidectomy (and already on the waiting lists of their respective
hospitals) varied so greatly throughout the country, and apparently with
no relation to age, to social class or to geographical location.

The second feature concerns the anxious parents who, having been
advised that " T's and A's " will improve the health of their first-born,
bring home from hospital a child whose speech, in those early days, may
be quite unintelligible. They accept reassurance that speech will improve,
as indeed it does, but gradually lose faith when they realize that the
normal speech which their child had before operation has not returned.
Faith is finally lost when the E.N.T. surgeon discharges the patient with
" normal speech " when parents and friends, but not the surgeon, can hear
obvious faults. Some patients are referred for speech therapy although
this, as a psychological method of treatment, only postpones the " moment
of truth." However, it may alter a parent's aggressive attitude and make
him feel that someone is interested and ready to help. In the cases seen
and treated at Oxford both attitudes have been encountered. Whereas
with the willing, understanding and cooperative parent corrective oper-
ation is carried out at an *early* date, the aggressive, frightened or deluded
parent requires sympathetic handling and corrective operation has had
to be postponed for a year or more. During that time the child and
parents should be seen at three-monthly intervals so that one may watch
deterioration in the child's educational attainments or emotional life.
Both of these are indications for a stronger approach to the parents to
consent to operation.

The logical treatment is to replace the adenoids—but this is not possible.
The next best is to produce the correct amount of projection, at the re-
quired level, on the posterior pharyngeal wall. This is a nice simple
mathematical problem, and may be solved by burying a portion of costal
cartilage behind the pharynx, under antibiotic cover. One patient was
treated by a Hynes pharyngoplasty which eliminated nasal escape and
speech returned to normal, as I thought. However, mother, having
heard her daughter speak for a decade before the disaster, did not agree
and disliked the very slightly diminished nasal resonance. Mother, as

you will understand, is a very critical assessor of surgical success in these cases.

Now if nasal speech can follow adenoidectomy, can it not occur when the adenoids shrink gradually with advance in years ? If we look for this condition we can find it, for in two recent surveys of the general population marked nasal escape of air during speech was found in about 6 per cent. of those examined (Renfrew, 1959 : Calnan, 1958). Figure 9
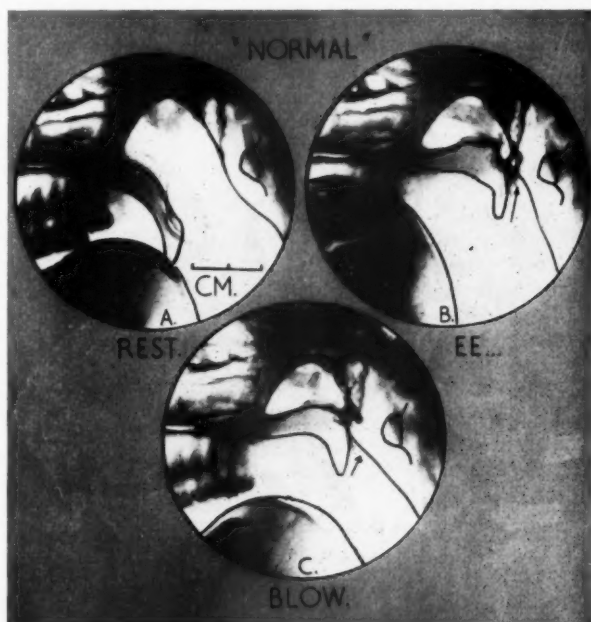
Fig. 9.

shows a patient who demonstrates what we might expect, although she also has a small Passavant's ridge to hide the real state of affairs (marked by an arrow). Her speech becomes markedly nasal when she is tired at the end of the day. So far she has resisted my persuasions and refused operation. In this she is probably quite right, but I do feel that we are now in a position to improve on Nature—the euphonious surgery of speech as one might say. After all the E.N.T. surgeon has been treating patients at the other end of the distribution curve of nasal resonance—by removing the adenoids for general stuffiness and difficulty in nasal breathing—for many years, and with success.

It is hoped that this brief survey of the subject has demonstrated that the study of speech disorders may be a fascinating, rewarding, intellectual,

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and therapeutic pursuit. Few surgical subjects allow one to delve into the ancillary disciplines of anatomy, physiology, physics, psychology, anthropology, biometrics and statistics, with a probability of making some useful contribution to each : One might add polemics and a little philosophy too—as John Hunter would have liked. The subject is particularly rewarding because so many of our patients are growing children who can be made completely normal citizens. These studies continue with the usual lack of support—material, financial and spiritual—a triad of hazards not new to post-war surgery in this country. This is particularly sad since, I would remind you, thirty-five years ago normal speech after cleft palate repair was rare. Because speech is so important in remunerative employment governments have the most to gain by providing some financial investment in such work. But governments do not think in this way : they expect us to stand still, whereas the choice today is progress or recession, with nothing in between.

Finally, it might be feared that this new look in surgery will deprive speech therapists of patients. This is not so, for in the past speech therapists have been expected to treat and cure nasal escape—which you will agree is virtually impossible—or worse still have had the invidious job of correcting articulatory faults in the presence of gross nasal escape, the modern substitute for the damnation of Sisyphus—and equally frustrating. On the contrary, the speech therapist has a necessary and valuable job to do, and with better diagnosis and better understanding of speech problems she, too, will be emancipated from the dead hand of yesterday. The story is only just beginning, for there are many other speech conditions to be investigated and treated, as indeed there always will be.

ACKNOWLEDGMENTS

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HAND SURGERY

AN OPEN MEETING of the Hand Club and The Second Hand Club will be held at the Royal College of Surgeons, Lincoln's Inn Fields, at 10 a.m. on Saturday, 28th November 1959. Lunch will be provided. Mr. Norman Capener will preside. The programme will include :

Mr. G. R. Fisk (London)   Trigger Thumb.

Dr. Erik Moberg (Gothenburg) The evaluation of Hand Sensation.

Mr. J. N. Barron (Salisbury), Mr. P. S. London (Birmingham) and Mr. R. H. C. Robins will speak on Hand Injuries.

Further details may be obtained from Mr. H. Graham Stack, 150 Harley Street, London, W.1.

RECENT VISITORS

RECENT OVERSEAS VISITORS to the College have included Dr. and Mrs. Walter McKenzie of Alberta, and Dr. and Mrs. Coppleson of Sydney.

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FREDERIC WOOD JONES—YESTERDAY AND TODAY

by

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INTRODUCTION

" *Knowledge, as opposed to fantasies of wish-fulfilment, is difficult to come by. A little contact with real knowledge makes fantasies less acceptable.*"—BERTRAND RUSSELL.

HISTORICALLY " THE COLLEGE " has a wonderful tradition in morphology—in fact in its own particular sphere it is unrivalled by any other institution. Following upon John Hunter's functional morphology there was a change to the more formal school. The Royal College of Surgeons saw within its precincts Richard Owen and William Flower. These formal anatomists were more concerned with the study of comparative anatomy and indeed added great contributions. Sir Arthur Keith and Professor Wood Jones as human anatomists concerned themselves with the animal kingdom at large. With Man classified as a mammal it became obvious in any study of human anatomy that his forerunners and relations stood in need of a certain degree of examination. All the above authorities have each in their own way added contributions to the annals of the College of Surgeons and I have chosen to speak on this occasion about the work of Professor Wood Jones ; of whom it could truly be said that he saw function and form as one and the same process. The influence of John Hunter and Richard Owen is particularly evident in his writings and contained in his Arris and Gale lectures. It is my intention to select three headings for discussion and I hope to show that some of Professor Wood Jones' work is of very great interest, particularly at the present time. It is exactly one hundred years ago that two communications were presented to the Linnean Society, the one by Charles Darwin and the other by Alfred Russel Wallace. These two naturalists arrived independently at a conclusion, namely, the part played by natural selection in evolution. This year sees the centenary of the publication of Charles Darwin's " *Origin of Species,*" a communication that might be said to have stunned the scientific world. Inevitably a great conflict was bound to arise with the teleologists, and what they had succeeded in suppressing for centuries was now to become a *fait accompli.*

If we can picture the position that prevailed one hundred years ago we shall readily understand the bitterness that was bound to arise and be continued for nearly one hundred years. I have often been reminded by Miss Jessie Dobson of the need to place the workers of the past within the surroundings and conditions obtaining in their day. It can be completely misleading to evaluate them on present standards. We must

therefore picture Frederic Wood Jones entering upon his career when it might well be said that the bitterness of the battle was at its peak. We must further remember the great difficulty the morphologists had in the past of relating animal to animal ; yet in spite of this an hypothesis had been put forward, and the logical conclusion was therefore that the science of morphology should substantiate or repudiate a postulation which was up to that time difficult to formulate on a morphological basis.

It is well to remember that Frederic Wood Jones kept uppermost in his mind a clarity which distinguished between fact and fancy. To him facts were self evident and no one was more minute or careful in recording scientific facts or indeed in checking the scientific facts of others. He was equally drawn to the summation of these scientific facts and this of course is where we find him frequently at variance with his fellow workers. His hypotheses or postulations never became creeds. It was necessary constantly to re-examine the conclusions in the face of new scientific fact. The dictatorial edicts of the high priests demanded an indoctrination of the student ; Frederic Wood Jones was disturbed that any re-examination of Darwinism was constantly squashed with the resulting stultification of scientific thought. Of him it could truly be said that he sought to provoke and inspire the student to analyse the evidence himself, he did not demand a discipline from his followers.

1. Man's place in the animal kingdom

" To arrange and to classify examples of organic life which he is surrounded by has been man's hobby from time immemorial. The desire to ' arrange the beasts of the earth after its kind ' seems to be inherent in human mentality." (*Man's Place among the Mammals.* F.W.J. 1929.)

In any scientific method we are confronted with two very distinct issues, the first is the one of observation which allows the second inference, to formulate some laws. Bertrand Russell (1949) tells us that Greek genius was deductive rather than inductive whereas the Arabs sought detached facts rather than general principles and they had not the power of inferring general laws from the facts which they discovered. It is important to understand the differences between the deductive method which is the inference by reasoning from generals to particulars in contrast to the inductive method of inferring a general law or principle from the observation of a particular instance. It becomes all the more important in analysing any animal classification from Grecian to Neo-Darwinian times to understand the purpose of the exercise as distinct from the method. Furthermore we must re-examine the inferences that have been drawn from these classifications which began with the simple exercise of classifying the animal kingdom " after its kind." There can be little doubt that this was the basis of all classifications until we entered the speculative period with its naturalists, its speculative philosophers, and its natural philosophers. It was in these later stages that we see the deductive

methods of teleology being gradually replaced by inductive methods and finally rather abruptly changed by both Darwin and Wallace.

Perusing the more ancient history, it has been interesting to note not only the purpose of classifying animals but upon what criteria such segregation was employed and changed from time to time. We must commence with Aristotle and his Zootoka which were later to be renamed the Mammalia by Linnaeus. The Zootoka were breathing vivipara which were divided according to their limbs into the dipoda or the bipedal race, the tetrapoda or the hairy quadrupeds, and the apoda or the whale tribe. We therefore find that the limbs are singled out as the basis of the classification and we shall further find that this basis persists in many respects until the present day though it may have suffered some changes in the interval. It has been possible with the extremities to effect further subdivision. The second group, the tetrapoda comprising the majority of the mammals, was divided into two groups according to the modification of the extremities. In the one case the digits were free, carrying some form of nail or claw ; in the other the digits were enclosed in some form of hoof. Later the terminology employed for these two groups was the unguiculata and the ungulata. Thus the three orders of the mammalia became broken down into more exact divisions, There was another means employed for further subdivisions among the smaller groups and to effect this the teeth were to be singled out for this purpose. Aristotle employed the teeth as a means of segregation for the unguiculata which can be instanced by the carnassial tooth as distinct from the teeth that do not interlock as in the herbivorous quadrupeds. The purpose of the exercise was solely to identify the likes and unlikes of the beasts. Accordingly they were united or separated on the basis of certain features. This was further governed by the ancient thought of " perfection " among the beasts and so we find the arrangement according to this criterion. Nevertheless even at this early period it was recognized that there were a number of features in common amongst the various divisions and correspondingly among the subdivisions. There was a stairway of perfection and man was placed at the top but apart on account of his unique possession of a soul. The classification was dominated by teleological views and the identity parade constituted classes and its then limited divisions and all were the act of creation forming a *scala naturae* or progressive scale of beings. I can do no better than refer to that excellent book by Professor Cole on the *History of Comparative Anatomy* (1944). He reminds us that " no definite or consistent classification of animals was drawn up by Aristotle ; but it is possible to construct one or more from his writings." Professor Cole further adds : " A *scala naturae* or progressive scale of beings was not formally accepted by Aristotle, but the idea was undoubtedly present in his mind."

We must now turn over the pages of history until we come to the year 1583 for this was the time of the appearance of a book entitled *De Plantis*

Libr . This was the work of Andreas Caesalpinus of Arezzo and the beginnings of the formation of a new system of arrangement. If we refer to Dr. William Whewell (1847) in his *History of the Inductive Sciences,* we find Caesalpinus was profoundly skilled in the Aristotelian lore but he was destined " to look onwards to a better philosophy. How are we to understand," he enquires, " that we must proceed from universals to particulars (as Aristotle directs), when particulars are better known ?" This was the beginning of a new line of thought but there is again a lapse of time and we have to wait until 1693 for John Ray to produce his *Synopsis Methodica Animalium.* Dr. Whewell informs us that John Ray was a fellow of Trinity College, Cambridge, at the same time as Isaac Newton. The interest of this is the relative development of biology as compared with the more exact sciences, a point which has often been the source of comment. Richard Owen (1859) had some remarks to make upon Ray's classification of viviparous four footed animals which is listed below :

A TABLE OF VIVIPAROUS FOUR-FOOTED ANIMALS

Viviparous hairy animals or quadrupeds are :—

Ungulate, and these either

Solidipedous, as the HORSE, ASS, ZEBRA.

Bisulcate, which are

Ruminants with horns, that are

Persistent, as in the Ox, SHEEP, GOAT,
Deciduous, as in the STAG.

Not Ruminants, as in the HOG.

Quadrisulcate, as the RHINOCEROS, HIPPOPOTAMUS.

Unguiculate, whose feet are either

Bifid, as in the CAMEL, or

Multifid, which are

With *digits* adhering together, and covered with a common integument, so that the extremities alone are visible at the margin of the foot, and are covered with obtuse nails, as in the ELEPHANT.

With *digits* in some measure distinct and separable from each other, the nails being

Depressed, as in APES, or

Compressed, where the incisor teeth are

Many, in which group all the animals are carniverous and rapacious, or at least insectiverous, or subsist on insects with vegetable matter :

The larger ones with the

Muzzle short, and head rounded, as the Feline tribe ; or with the
Muzzle long, as the Canine tribe ;

The smaller ones with a long slender body, and short extremities, as the Weasel or Vermine[1] tribe ;

Two very large, of which tribe all the species are phytivorous, as the HARE.

[1] Genus *Vermineum,* from their worm-like form.

A glance at this classification shows that man and whale are omitted. The interpretations may be Ray's wish to limit the discussions or it may well be that his vision fell short of that of Aristotle. Sir William Flower (1891) thought that Ray's classification of the mammalia was the first serious attempt at the separation of the ungulates or hoofed animals from the unguiculates or nailed and clawed animals.

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Whereas Caesalpinus might be described as awakening interes in botanical systematics so also we must accord to John Ray the counterpart in the animal kingdom. About this period Professor Wood Jones (1929) reminded us that Sir Thomas Browne (1605-82) in his *Religio Medici* was mindful of a scale of animals varying from lower forms to higher forms. He quotes the following passage from *Religio Medici* : " there is in this universal stair, or manifest scale, of creatures, rising not disorderly or in confusion, but with comely method and proportion." Professor Wood Jones also calls our attention to Charles Bonnet (1720-93) who " embraced the concept of the stairway of Nature and carried his grandiose échelle des êtres to extreme lengths " . . . and Charles White of Manchester (1728-1813) who independently introduced the idea of " regular gradations " in Nature into current English literature.

It is from now on that we see the beginnings of a change in outlook taking place. Advances in study are suggesting to Charles White how difficult it is becoming to separate the classified. This is not to infer that it is the end of taxonomics but rather a different trend of thought. The accumulated knowledge is being analysed in greater detail. It would serve no useful purpose to attempt a broad coverage of the widening interests ; it will be sufficient to choose just a few lines of thought from now onwards.

There can be little doubt of the immense debt we owe to Linnaeus (1707-78). He restored order which was becoming necessary and his contributions laid the foundations upon which modern systematics were to be built. As Richard Owen (1859) states, the term Zootoka ceased to be and in its stead the appropriate and distinct term—the class— mammalia—was substituted. Linnaeus like Ray was to found his primary divisions upon the locomotive organs and secondary divisions or orders chiefly upon the dental structures. The abridged classification of Linnaeus below (taken from Richard Owen's book (1859)) instances the importance of the dental system :

MAMMALIA

Unguiculate

Front teeth, none in either jaw	..	..	..	..BRUTA.
Front teeth, *cutters* 2, laniaries 0	..	..	..	..GLIRES.
Front teeth, *cutters* 4, laniaries 1	..	..	..	..PRIMATES.
Front teeth, *piercers* (6, 2, 10), laniaries 1	..	..	..FERAE.

Ungulate

Front teeth, in both upper and lower jaw	..	..	..BELLUAE.
Front teeth, none in the upper jaw	..	..	..	..PECORA.

Muticate

Teeth variable	..	..	..	..	..CETE.

We are familiar with the terms unguiculata and ungulate but now we see appearing the muticate, the mutilated or maimed animals. This raises some very important issues which I shall refer to later. In the meanwhile, before we pass on to the next great work on the animal kingdom by Baron Cuvier, let us acquaint ourselves with John Hunter

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(172.-93). Hunter was interested in classifying animals but in a different way. He was not in the true sense a classifier but he could not help relating animal forms according to their function. This was then a break in the traditional method that had been employed to a large extent to date. The museum John Hunter created, now at the Royal College of Surgeons of England, has been preserved as a very fine memorial of his efforts. Thomas Henry Huxley in his introduction to the classification of animals (1869) speaking about this collection says " it was intended to illustrate the modifications which the great physiological apparatuses undergo in the animal series ; the classification which he adopted is a classification by organs, and, as such, it is admirably adapted to the needs of the comparative physiologists." It is well to bear in mind this great contribution with regard to function as opposed to form, for we shall see later what part the work of John Hunter was destined to play in the thoughts of Frederic Wood Jones.

The mention of Baron Cuvier (1769-1832) immediately brings to mind his contribution in 1816—*Le Regne Animal*. Perhaps I might be allowed to refer to the English edition published in 1849. We find Cuvier, like so many before and after him, expressing views that render it difficult at times clearly to understand the precise nature of thought in certain instances. This can account for the confusion appearing at intervals in the literature where various authors take a fragment of the work to suit their own particular convenience. With this thought in mind coupled with a possible accusation of meeting my own purpose I venture to record the following from Cuvier's work (1849) : " I must observe that I have neither pretended nor desired to class animals so as to form a single line, or as to mark their superiority . . . I regard my divisions and sub-divisions as the merely graduated expression of resemblance of the beings which enter into each of them ; and although in some we observe a sort of passage of gradation from one species into another, which cannot be denied, this disposition is far from being general. The pretended chain of beings, as applied to the whole creation, is but an erroneous application of those partial observations, which are only true when confined to the limits within which they are made ; and in my opinion, it has proved more detrimental to the progress of natural history in modern times, than is easy to imagine." Let me add one further paragraph : " there remains to ascertain which are the most influential characters of the animals that should serve us as the basis of their primary divisions. It is evident that they should be drawn from the animal functions ; that is to say, from the sensations and movements ; for not only do both these make the being an animal, but establish in a manner its degree of animality."

If the classification employed by Cuvier is examined it will be noted that there has been a great step forwards. I think there is little need to comment on the arrangement of mammalia which I have obtained from Richard Owen (1859).

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TABLE OF THE SUBCLASSES AND ORDERS OF THE MAMMALIA, ACCORDING TO CUVIER

MAMMALIA

UNGUICULATA

With three kinds of teeth.

BIMANA	..	..	..	..	*Homo*	Man.
QUADRUMANA	..	..	..	..	*Catarrhina*	Ape.
					Platyrrhina	Marmoset.
					Strepsirrhina	Lemur.
CARNARIA[1]	..	..	..	..	*Cheiroptera*	Bat.
					Insectivora	Hedgehog.
						Shrew.
						Mole.
					Carnivora	Bear.
						Dog.
						Seal.
MARSUPIALIA	..	..	..	..	*Didelphys*	Opossum.
					Phalangista	Phalanger.
					Macropus	Kangaroo.
					Phascolomys	Wombat.

Without canines.

RODENTIA	..	..	..	..	*Claviculata*	Rat.
					Non-claviculata	Hare.

Without incisors.

EDENTATA	..	..	..	..	*Bradypus*	Sloth.
					Dasypus	Armadillo.
					Myrmecophaga	Anteater.
					Monotremata	Echidna.
						Ornithorhynchus.

UNGULATA

PACHYDERMATA	..	..	..	..	*Proboscidia*	Elephant.
					Ordinaria	Hog.
						Tapir.
					Solidungula	Horse.
RUMINANTIA	..	..	..	..	.. ..	Sheep.

MUTILATA

CETACEA	..	..	..	..	*Herbivora*	Dugong.
					Ordinaria	Whale.

[1] Written *Carnassiers* by Cuvier.

Cuvier has long been regarded as one of the antagonists to evolution. I have often felt that this criticism is unjust, partly on account of the period of his work, and partly on account of his tremendous knowledge of the animal kingdom. Such knowledge did not permit the formation of grandiose schemes, even though he was one of the earliest to embark upon a study of fossil material. We must remember Cuvier, like John Hunter, brought the function of the organism to the fore and he attempted to relate this to his formal morphology. Can there be any surprise that the work of these two great men was bound to play a large part in the thoughts of Frederic Wood Jones?

Up to the time under discussion we have seen the mammalian classification established on certain morphological features. Although the main purpose has been one of segregation one can perceive the change suggesting

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so..1e bond of union between the beasts. Furthermore the function of the animal has been brought into prominence and thereby a vast new field for study has been opened up. It was around this period under discussion that the great French scientist—Jean Baptiste de Lamarck (1774-1829)—appeared on the scene. In contrast to the fairly unanimous opinion of the immutability of species to date Lamarck was not only to record opposition to this doctrine but also to establish the first evolutionary theory. In this respect Erasmus Darwin (1731-1802), the grandfather of Charles Darwin, ought not to be lightly passed over ; Erasmus Darwin and Lamarck had much in common. Discussion on Lamarck's works in any detail would be out of place as this would prove a task in itself. It is, however, important to note that this is yet another milestone in the history of evolution and has been responsible for yet another change in outlook. A change perhaps that never came to stay because science has yet to understand the influence of function upon the organism's offspring.

There can be little doubt that Wood Jones believed there was a place for the work of Lamarck. If we refer to *Habit and Heritage* (1943) we shall find Wood Jones discusses the matter in some detail. Mentioning Nature and Nurture he says : " Today the battle has been won for Nature (or genetic constitution) and Nurture has ceased to be regarded as being of any importance whatever in the ultimate stock. It is only the germinal constitution—the type and disposition of the hypothetical genes—that counts. If all is well with these, the environment in which the stock happens to find itself makes little or no difference." This book will be familiar to a number of people and there is little need for me to quote any further. If some of Professor Wood Jones' arguments appear out of date I should recommend to such a reader a recent book by Professor Graham Cannon (1958) who holds the Chair of Zoology in the University of Manchester. This book is titled *The Evolution of Living Things*.

It becomes a dreary business browsing through the literature appertaining to classifications. I have only given, in so far as we have gone, some of the early views to a large extent concerned with uniting the like and separating the unlike. If we are to proceed further we shall find that the increase in knowledge makes our classification stifled with detail. There is also a great tendency for the classifiers to add to the four divisions of Linnaeus, namely, the classes, the orders, the genera and the species. The end production of this highly detailed organising of the animal kingdom inevitably can become very confusing. Let me finally briefly mention a few of the contributions made suggesting a more detailed and complete classification.

The basis of these classifications have been in the main morphological and we could recite instances from Richard Owen, from Milne Edwards, from Von Siebold and Stannius, and from Leuckart ; we could recite instances from the more physiological systems of Oken, Fitzinger and

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M'Leay; we could recite embryological systems from Von Baer, Van Beneden, Kolliker and Vogt. These and many others are discussed by Louis Agassiz (1859) but the purpose of this paper is not an exercise in classification. If it were so we could, like Herbert Spencer (1898), take the parallel of classifying books in our library. The librarian may choose to list his books according to the author's subject. In the case of the subject matter he very soon finds himself involved with endless subgroups of his greater groups. Some books will manifest distinct and clear features such as works on anatomy, anthropology and genetics amongst others where no difficulty arises in as far as the classifier is concerned. But how are we to classify Professor Wood Jones' book *Man's Place Among the Mammals*? Is it zoology, is it comparative anatomy, is it physical anthropology?

There were undoubtedly differences of opinion as to the best basis of classifying the animal kingdom but on the whole up to this stage it might be said that there was no serious disagreement. The book could be classi-fied according to its title, or its author, and it was to a large extent a matter of the particular individual's preference possibly influenced by his own speciality. Following the work of Wallace and Darwin in 1858 and more particularly Darwin's completed work on the *Origin of Species* in 1859, classifiers had to adopt a more serious outlook. Not long after this time, 1869, we were to see the first of a series of genealogical trees appearing. Credit for the first tree has been accorded to Ernst Haeckel, the professor of Zoology in the University of Jena. It is superfluous for me to add that this became a very fashionable pastime and individuals no less than Sir Grafton Elliott Smith, Sir Arthur Keith and Professor W. K. Gregory amongst others added their contributions. The classification of the animal kingdom was draped around the tree as indeed are the electric bulbs attached to a flex placed upon the Christmas tree of today. This arrangement of the animal kingdom was thereby transformed into what Wood Jones described as " end on evolution." As the mysteries of the past were gradually obtained from the earth's crust so the connecting limbs of the tree were gradually strengthened. This very naturally led to the popular pursuit of looking for the " missing links." The stairway of life might be truly described as imperfect at certain points and this led to great activity to reinforce the ladder at these vulnerable places.

Let me remind you what Wood Jones said : " Animal progress is far more complex than any mere procession climbing a long ladder. There are many ladders and many climbing processions." One cannot help remarking that if the animal kingdom was to be interpreted as a single file procession we should undoubtedly have advanced a great deal further. It is a complex jig-saw puzzle, as Wood Jones says, with many ladders.

In fairness it must be pointed out that the general interpretation was not really as simple as I have indicated. Many problems have been dis-cussed, as for example, parallelism ; and a tremendous amount of thought

has been devoted to this and other aspects of phylogenetics. Nevertheless to the vast multitude of unthinking people the popular hypotheses that have been displayed before them have undoubtedly conveyed the impression of the unbroken series or perhaps more correctly the series with a few gaps which were gradually filled in by the fruits of palaeontology.

I have often paid tribute to Darwin and on this occasion I was wishing to emphasise his great caution backed by profound thought which seemed so different from some of the lighter-hearted individuals that have been classified as Neo-Darwinians. The difficulties leading to endless disputes of little value rarely if ever stem from Darwin himself. Darwin was, I have said, cautious and turned the problems over in his mind : a few quotations from the *Origin of Species* will bear out this statement : " The natural system is a genealogical arrangement, with the acquired grades of difference, marked by the terms varieties, species, genera, families etc. : and we have to discover the lines of descent by the most permanent characters whatever they may be and of however slight vital importance." Darwin has stated that "I am convinced that natural selection has been the main but not the exclusive means of modifications," and finally I quote " A grand and almost untrodden field of enquiry will be opened, on the cause and law of variation, on correlation, on the effects of use and disuse, on the direct action of external conditions and so forth."

Is it any wonder that Wood Jones set himself the task " to discover the lines of descent by the most permanent characters " convinced that Natural Selection " was the main but not exclusive means of modification ? " Is it any wonder that " the causes and law of variation . . . the effects of use and disuse . . . the direct action of external conditions " should arouse his attention.

2. Man's schooling in the arboreum

" Arboreal uprightness preceded terrestrial uprightness ; and it is the purpose of these studies to show, in some measure, the extent to which man is indebted to, and was perfected in arboreal life." (*Arboreal Man.* F.W.J., 1916.)

It is of little use reading the works of Professor Wood Jones if one is not prepared to allocate some part to function as an effective agent in the evolutionary process. The Hunterian tradition was deeply ingrained upon his mind and he added Lamarckian principles in order to make the story of function as a factor in the evolutionary process complete. This was not to the exclusion of formal morphology. In any discussion of this nature there is inevitably the time-old conflict of function and form. We may be prepared to take the line—the orthodox teaching of the last one hundred years—that variations occur through the agency of chance and such changes in the organism are subjected to a form of selection. On the other hand we may be disposed to the opinion that function is of

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prime importance, or at least has a place allocated to it in the unfolding process. The striving of the animal to improve its lot whether it be some advancement in the arboreal habit with consequent changes in the hand and foot or the adjustments in the snout of the animal brought about by different methods of feeding.

The above quotation from *Arboreal Man* is the substance of the task Wood Jones undertook in analysing man's ancestry. This book was followed by a small pamphlet two years later titled *The Problem of Man's Ancestry*. The reaction to these publications was mixed but there is no doubt that it was unacceptable to the Neo-Darwinian school. The conclusion of Wood Jones that Man was of Tarsian origin, was contrary to the popular Simian hypothesis.

Darwin—as we have seen—modestly regarded his work as the beginning of a sounder line of thought. His knowledge was not conclusive enough for finality and honour must be accorded to him on this account and his desire that further progress would be made. I think it is reasonable to conclude that Darwin dismissed Lamarck's work from his thoughts in his earlier work but in later years he began to feel that it should be given some consideration. It is my opinion that the Neo-Darwinians ignored this aspect, and in fact excluded it from their work on the score that acquired characters could not be inherited. Partly in answer to this attitude of mind it could be said that few were competent to undertake a study of the function of the animal. The morphologist had the training of the formal line of thought. Hunter, Cuvier and Lamarck were dead, and few sought to investigate or understand function. If we accord no other appreciation to the work of Wood Jones, we can at least say he carried out and added to, in no mean way, this very valuable line of thought.

Linnaeus, the founder of the order of the Primates, admitted to this select company man, the anthropoid apes, the monkeys, the tarsiers, the lemurs and the bats. Needless to say the Bats were not to enjoy this privilege for very long but they survived until shortly after 1870. In this year we find the British Museum arrayed upon these lines. The change came, as Wood Jones tells us, when St. George Mivart published his communication in the Proceedings of the Zoological Society of London in 1873. Wood Jones quotes Mivart's criteria for the primate order as follows : " An unguiculate claviculate, placental mammal with orbits encircled with bone ; three kinds of teeth, at least at one time of life ; brain always with a posterior lobe and calcarine fissure ; the innermost digits of at least one pair of extremities opposable ; hallux with a flatnail or none ; a well marked caecum ; penis pendulous ; testes scrotal ; always two pectoral mammae."

Let me divert for a moment to refer to the authoritative work of Dr. George Simpson published in 1945 in the Bulletin of the American Museum of Natural History. This paper was titled *The Principles of*

Classification and a Classification of Mammals. With regard to classification Dr. Simpson says : " each group of the system has a fixed model, an archetype, consisting of a given set of morphological characteristics, and any animal that agrees, in this set of peculiarities, with the archetype belongs in that group." This definition cannot be in any way regarded as having profound attributes but this is no wonder for Sir Wilfred Le Gros Clark (1950) has reminded us in his very helpful book written for the lay reader that " A satisfactory definition of the term ' species ' still defies the ingenuity of the Zoologists, but, as a rough approximation, it may be said to consist of a homogenous group of individuals closely resembling each other (except for relatively minor variations, such as those of moderate differences of size and colour), and usually capable of interbreeding freely and producing fertile offsprings."

One cannot help remarking that the criteria for the primate order, or indeed the mammalian class, is a peculiar mixture of functional and formal morphology, but there can be no doubt that the problem at the present times defies further elucidation. Wood Jones showed no great interest in classifying ; he concentrated upon animal relationship and, in particular, that of man within the mammalian group. There were two fundamental aspects that he sought to clarify—these are best expressed in his own words : " If we are to form a just conclusion regarding the true position of any species in its own phylum, there are two lines of anatomical investigation that must be pursued. In the first place it must be determined if the animal possesses an assemblage of basally primitive characteristics as to prohibit the possibility of its derivation from those of its fellows that have lost this primitiveness by the development of phylogenetic specialisations. In the second place it must be ascertained if the animal has developed any outstanding structural specialisations of its own that are not shared by any of its fellows." It was natural that Wood Jones in attempting to answer the problem sought to understand the function of the organism and equally at the same time to analyse certain primitive morphological features. The whole problem is an interwoven complex. Supposing, for example, we refer to Chapter XIV in *Arboreal Man* we shall find it headed " The recession of the Snout Region " and we shall be able to observe the theme of explanation : " A typical primate obtains its food with its hand instead of adopting the common mammalian method of taking it with its mouth : one function of the mouth, that of food-getting, is therefore relegated to that of the hand in the Primates." Not only the snout is affected but : " If it is the hand which becomes the grasping organ, the mouth and the anatomical structures connected with it need no longer be developed in any special way to carry on this function." " I am terming this change which hand-feeding produced *the recession of the snout region.*" Wood Jones looks upon the animal in its entirety. " Now teeth are developed for different purposes. They are developed for cutting herbage, for seizing animal food, and for killing prey as well

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as for biting up preparatory to swallowing." He then traces the t oth series, through the forty-four teeth in the terrestrial insectivora, the th rty-eight in the tree shrews, the thirty-six in the lemurs and the thirty-tw o in the remaining higher mammals of the primate order. We have the evidence of Dr. Duckworth contained in this book : " As they gradually acquired the habit of using stones, clubs and other weapons, for fighting with their enemies, they would have to use their jaws and teeth less and less." This is the beginning of the next chapter (XV) where Wood Jones seeks to relate the recession of the jaws with the reduction of the tooth series. This is of profound interest to us today where we find mongrel man displaying further reduction in the thirty-two teeth series. Man's face has become vertical but evidence could be brought forward to show that in some cases it has always passed beyond this stage and certain individuals demonstrate almost a concavity in the middle third of the face. We need not linger upon this well-known explanation for we must pass on to briefly mention a few other comparable examples.

We could discuss the spinous processes of the vertebral column : " In actual disposition these spinous processes differ greatly in different animals; and the most conspicuous differences are to be noted in the direction in which they slope. Some, or all of them, may stand up quite straight, or they may lean towards the head end, or the tail end, of the animal." We find Wood Jones passing on to the next chapter saying : " The differences seen in the disposition of the cervical spinous processes in the anthropoids and in man are due to, and involve, yet another factor which may be termed the poise of the head upon the vertebral column." Yes, gradually he proceeded by meticulous analysis to study the organism's function as a whole.

Wood Jones' explanations on the limbs are too well known to need repetition and perhaps we might end this portion of the paper by saying that behind all this effort Wood Jones was seeking to explain to his own satisfaction man's ancestry. The culmination was of course his suggestion that man was of Tarsian origin. He was of the opinion that specialization in the Simian group had proceeded too far in the wrong direction and there was no turning round the corner. Let us quote his own words : " Man must have come from the primary stem at an extraordinarily early period. He must have started an independent line of his own, long before the anthropoid apes and the monkeys developed those specializations which shaped their definite evolutionary destinies." Speaking of the Tarsiers he says " He lingers today, a specialized primitive primate, nearer akin to man than any other animal known to the Zoologists."

These conclusions were naturally the source of irritation and Professor Wood Jones was called to task when he was asked to support his Tarsian hypothesis against a most formidable array of experts wedded to the Simian explanations. The battle ground was the Zoological Society of London and the date 1919, the contents of the discussion is recorded by

this Society's proceedings. There was unanimity on one sole point and that was everyone regarded Tarsius as a " living fossil." Apart from this no useful purpose can be served by repeating the ancient threadbare arguments. Such " head-on " collisions add little to the advancement of our subject, neither side gives way and the result is a complete impasse. We should do well to avoid continuing this argument as contained in Professor Wood Jones' Douglas Price lecture in Brisbane devoted to man's ancestry ; be it the some thirty pages in the Proceedings of the Royal Anthropological Society's Journal of 1930 where Professor Ashley-Montague opens the subject afresh ; be it the numerous exchanges of opinion between Professor Wood Jones and Dr. W. K. Gregory.

We are aware of the difficulty experienced today of interpreting the Lamarckian laws to the fullest extent. But we must ask ourselves if this is sufficient reason for their exclusion. We must face up to certain problems. It is so easy to speak about the adaptation of the organism to its surroundings but this is merely evading the question. I, like others, find that certain explanations offered by Wood Jones might be criticised, that is to say, some of the details. What we must bear uppermost in our mind is the general overall principle. I believe Professor Wood Jones could not accept the functional adaptations in life as a meaningless episode to be repeated in perpetuity without being offered any rôle in the evolutionary process. Regardless of the fact that science had been unable to explain the mechanism Wood Jones stuck to his guns and was not deterred from the teachings of John Hunter, of Cuvier, and of Lamarck. His explanations at times might be regarded as frail, it was his hope that these might be reinforced by his successors, particularly those who looked upon function and form as inseparable. We will not pursue this topic any further, if so we could embark upon " Habit and Heritage." What we have been trying to appreciate so far is the rôle played by function and its possible effects as opposed to the study of pure formal morphology.

3. Man's yardstick

" Possibly there would be a gain in clarity of thought upon the question of human origins if we could free our mind from the influence of the teaching, so long inculcated by writers on the subject, that Man's upright posture is a secondary affair, derived naturally and inevitably as an outcome of his having passed through a stage of evolution in which he could be likened to a sort of glorified Anthropoid Ape akin, we might suppose, to a somewhat refined Chimpanzee. The human orthograde bipedal habit of posture and progression was certainly no by-product of any activity such as existing Anthropoid Apes display. It was an aromorphosis in its own right—an achievement of primary importance, since it was not the product of the other human characteristics : it was the initiator of them all." (*Hallmarks of Mankind.* F.W.J., 1948.)

We all agree that man must reach a decision as to the best method that

he should employ in reaching any conclusion with regard to evolution, but the difficulty arises in deciding what is in fact the best method. We may, in fact, eventually come to the conclusion that there is no single method on account of the wide number of specialists concerned varying from genetics, palaeontology, zoology, anatomy and embryology, to mention a few. It is for this reason that we see each specialty employing its own method and naturally each one will maintain that their own particular one is of at least equal importance to any other that may be employed. It therefore follows that we are really unable to point to any one yardstick. In employing, however, our own individual yardstick we must give due consideration to the yardsticks of allied branches of science. The danger that is always present is a very obvious one—specialists in the same subject have been known to differ—we have seen this difference of opinion expressed in the Simian and Tarsian hypothesis of man's origin. For specialists working outside the field of anatomy it becomes a matter of individual choice. Wood Jones did not follow the familiar pattern of thought so it is not surprising that his works should have been set aside for the more popular beliefs. His Tarsian hypothesis cut across all the beliefs of the Neo-Darwinians. For confirmation of their own pet theories they required the anatomical results showing that the likeness, and to them, the unlikeness, that was stressed by Wood Jones was on the whole not very popular.

Let us quote from a recent book by the Prosector of the Zoological Society of London (1954). Professor Osman Hill has been to some pains in studying the primates and he has published books on this mammalian order. I think his views are best expressed in his own words and I have taken them from his book *Man's Ancestry*.

" There have been, from the earliest days, serious students who have pointed out shortcomings in the anthropoid-ape-hypothesis ; and some of these have suggested alternatives, though few of them have been seriously considered. Mivart (1873) emphasised that Man had no special affinities with the great apes any more than with monkeys, and that in many respects he was just as nearly approached even by lemurs. Cope (1885, 1896) an American palaeontologist, also stressed this likeness to lemurs, though the genus to which he specially affined the human stem was one that is now classed as a tarsioid. He derived both Man and apes from a fossil Eocene tarsioid to which he gave the name "Anaptomorphus homunculus ", but which is now relegated to a different genus— Tetonius. The embryologist Hubrecht (1897), following up Cope's dicta, made a special study of the early development of Tarsius and found that his results favoured Cope's hypothesis. But Wood Jones (1918) has been the most vigorous proponent of the so-called tarsian hypothesis. This authority has persistently maintained that Man, together with all the higher Primates, has arisen directly from a Tarsius-like ancestor, any common structural features between Man and the apes and monkeys

being due to parallel evolution. The apes have too many specializations of their own ever to be considered, even in their Miocene representatives, as direct ancestors of Man ; and the same holds true to a lesser degree for the catarrhine monkeys. Man, on the other hand, retains many generalised features which both monkeys and apes have lost."

Professor Osman Hill draws attention to the views of a few other authorities but there is no need to extend on this matter and I shall just quote one other paragraph :

" Allowing for the possibility of disagreement from improper delimitation of terms, Straus concludes that a non-anthropoid hypothesis of man's origin fits the facts better than the anthropoid-ape-hypothesis ; and with this conclusion the present author, on the basis of his own researches, agrees. The hominid line, after emerging from the common Eocene pool of tarsioids must have been represented by Parapithecus. The line leading to the apes separated from that which gave rise to Man probably in the Oligocene."

Professor Wood Jones belonged to the select band of a few who differed fundamentally from the Darwinian Thesis. He was undoubtedly the greatest exponent of man's non-anthropoid origin and I believe history will accord to him a place in her annals but like the recognition of Mendel it will take some time.

It was my original intention when discussing " Hallmarks of Mankind " to have made some reference to Professor Wood Jones as the formal morphologist ; we could have discussed the premaxilla—one of his favourite topics, the pterion, the jugal bone and numerous other points. I decided, however, upon second thoughts, to continue discussing what I believe is Wood Jones at his best—his Hunterian frame of mind. There is a second reason and one which I believe shows Wood Jones' greatness— he changed his mind ; man's education in the arboreum savoured too much of difficulties and re-examination of his Tarsian thesis was necessary. He therefore proceeded in the concluding portion of *Hallmarks of Mankind* to sow seeds of a slightly different nature.

We should do well—at this stage—to enquire what are the " Hallmarks of Mankind ? " Are they seen in the premaxilla, the pterion, or are they seen in man's functioning machine ? Are they his orthograde posture ?— unique unto himself. The reader will remember that I remarked upon the definitions of classes and orders since I found them a strong mixture of functional and formal elements and now we are confronted with the same problem in electing to define a Hallmark for Mankind. John Hunter had no doubts—the teeth were denoted according to their function.

If we revert to the quotation at the beginning of this section we shall see the change of mind evident when we compare it with the heading of the second portion of this paper. Professor Wood Jones is casting doubt on his own work and wondering in his re-examination if it cannot be improved upon. He is still pondering over the same problem, man's

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upright posture and now he wonders if he was educated at all in the arboreum.

There can be little doubt man's functioning body in its mode of progression is unique. We have been assured by very great authorities that anatomically the changes are merely a matter of proportions, basically they are akin. For arguments sake we will accept this formal morphological observation, but under some protest. We will limit our discussion to man's skeletal machine—the one that moves him around in an upright posture. What are the types of animal progression among the reptiles, the birds and the mammals? Basically these can be divided into two groups: the first in which all four limbs are identical in serving the same need. The majority of the mammals are in this category—the four limbs are to a very large degree used for the same purpose whether this be climbing trees or it be walking upon the ground. The second group manifest very different functions for the fore and hind limbs and as examples of this type we can offer the birds and man. The wing of the bird differs from its foot in a degree equalled by the corresponding parts of man. With these two different types we see manifest two very different types of machine employed for moving the creature. In comparing these creatures we can take the four hoofs of the horse, or the ox, and note the difference from the wing and the leg of the bird. There is a range of creatures among the bats and the marsupials where we can say there are well defined differences. Of the carnivora, whilst manifesting unity of purpose in the claws, it could be said as with other animals that the forelimbs are perhaps a little more specialized and used for feeding and the killing of prey. The basic need in all animals is an effective means of transport and this is performed upon two feet, two wings, four feet, or four hands as in the case of the arboreal inhabitants. This then is number one need, the machine essential for life, and additional to this there must needs develop other secondary features, be they for defence or attack or some means of feeding, etc. What we must decide in considering the ingredients for an archetype are the inclusion or the omission of the Hallmarks of the animal's means of progression.

If we include the means of transporting the animals we must of necessity admit a place in our classifying system to function. If we do so it does not follow that we shall wreck havoc with our present system—on the contrary, it would lead to a much greater degree of clarification. The repercussions of this suggestion upon the primate group are in fact considerable in as far as man is concerned. The question we have to ask ourselves is a simple one and it is whether it was really necessary for man to go to school in the arboreum? The answer to this question must be no, nature has other ways and means of perfecting the orthograde posture.

Let us return to the thoughts of Professor Wood Jones on this aspect. I am afraid that I must quote at some length : " Obviously, the complete emancipation of the hand from any office of support, or of progression,

is a correlation with the attainment of the orthograde bipedal posture. The attainment of the orthograde posture is an example of what Sewertoff (1931) termed ' aromorphosis ' which. following Zeuner (1946), we may define as follows : ' An ordinary adaptational character may be highly adaptive to a certain manner of life, and may be very useful, but it does not contribute to increasing the life-energy of the form. The aromorph, however, does so.' An aromorph is, in fact, a change in function and structure that produces a host of other changes in its wake, opens the way to a vast number of new developments and makes possible advances unattainable in the absence of the change. It was this adoption of an orthograde posture, coming as it must have done as an accomplished fact during a favourable phase of evolutionary development, that produced the profound changes, both quantitative and qualitative, that sever man altogether from the assemblage of the Anthropoid Apes."

Do we not sense a change in its beginning ? Is Professor Wood Jones doubting man's early arboreal life ? To continue : " Of necessity an animal is pronograde or orthograde. There is no halfway stage in posture. It would be better to discard all the drawings that depict the early progenitors of man as slouching brutes carrying themselves in postures incompatible with the dictates of gravity, and to relegate to oblivion all the speculations and theories concerning the gradual rise of man from a quadrupedal pronograde to a bipedal orthograde posture. Man's ancestors attained to uprightness by an aromorphosis that was completed as a functional entity, just as temporary uprightness is resorted to on occasion by bears, marmots and many other mammals. Doubtless after the attainment of the functional change structural adaptations were perfected in order to remould certain parts to the demands of the alteration in posture. But to misinterpret these structional readjustments as indications of a gradual assumption of the posture is to abandon the great biological principle that function is the creator of structure and not its offspring."

With regard to the means of attaining the orthograde posture Wood Jones states : " The differences between the bodily structure of an animal attaining uprightness through suspension by the hands and one gaining uprightness by standing on the feet are exactly those made evident by the study of the anatomy and ontogeny of the limbs of Apes and Men.

An alternative must therefore be sought to the untenable theory of the brachiating origin of human bipedal erectness. Many mammals of several different orders have attained to a certain degree of bodily uprightness and bipedal progression by adopting a saltatory habit. The saltatory and partially upright marsupials are derived both from the Polyprotodont (Antechinomys) and Diprotodont (Macropus) sections of the phylum. The insectivora have begotten saltatory forms in Macroscelides and Rhyncocyon. The rodentia have produced innumerable Jerboas and jumping mice as well as the remarkable Cape Jumping Hare (Pedetes). The Strep-

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sirhini have developed the saltatory Bush Babies (Galago), and even among the Haplorhini the modern representative of the Eocine tarsioids (Tarsius) is a saltatory animal.   All these forms are to a certain extent bipedal in some phases of progression and all are capable of attaining to a certain degree of bodily uprightness.   But all highly specialized saltatory forms develop three well-marked characteristics : (1) the habit of perfected leaping demands so great a leverage in the foot, below the ankle joint, that great lengthening of some element of the foot (tarsus, metatarsus, or digits) is necessary : (2) such bodily uprightness as is attained is effected on a hind limb flexed either at the hip or knee or at both joints : (3) a specialized balancing tail, often tufted at the tip, is usually developed. These three characteristics would clearly seem to rule out any perfected leaping form from having any place in human ancestry.   The human foot could never have regained the more primitive proportions had saltatory modifications ever been fully established.   Moreover, it appears that the saltatory habit is incapable of producing the condition by which the body is carried on a hind limb extended at both hip and knee and supported on a plantigrade foot.

Other animals have attained to bipedal progressions and a certain degree of bodily uprightness by adopting a specialized type of cursorial habit.   Certain lizards, and most dramatically the large Chlamydosaurus of Northern Australia, habitually run, when pressed, erect upon their hind legs.   This habit is shared by many other lizards, such as Amphilolorus, that live in open country.   Probably all palaeontologists would agree that the great extinct bipedal Dinosaurs attained their distinctions from ancestors that possessed the aptitudes shown by these modern lizards, and following the work of Baron Nopesa and of Percy Lowe, the bipedal habit of the Ratite birds and the attainment of flight by the Carinates may be assumed to have followed the same route.   But again, with the attainment of bipedal progressions, by specialized adaptations to rapid cursorial locomotion, structural modifications are produced that prohibit us from supposing that the acquirement of man's orthograde posture could have come about by such means.   It therefore seems definite that man did not become an orthograde, plantigrade biped by specializing either in perfected saltatory or rapid cursorial activities.   But there is a middle course by which certain mammals rear themselves up and walk upright on plantigrade feet."

Finally Wood Jones turns to formal morphology : " John Hunter made the shrewd observation that ' the animal next to the human, after the monkey and the mocock (lemur), in the shape of body is the bear, and and his actions, of course, are equally near ; but he is not equally near in every part.   His greatest likeness is in his four extremities.'   Later, in describing the anatomy of the bear, he notes ' the extremities come nearer the human.'   After Hunter, Sir William Lawrence noted the similarity of the plantigrade erectness of the bear to human uprightness, and he

remarks that to all the distinctions that he has drawn between typical quadrupeds and upright man the bear is an exception. Writing of the osteology of the carnivora, Owen says, ' The femur is remarkable, in bears, for its great length and superficial resemblance to that of man.' And elsewhere he notes the similarities between the human and ursine foot . . . Man did not gain his bipedal uprightness by an apprenticeship of becoming a specialized hand-swinger : of that we may be quite certain. Almost equal certainty may be attached to the rejection of the possibility that he ever served an apprenticeship as a specialized leaper or a specialized runner in open spaces. But it is by no means so easy to reject the supposition that he commenced his career of bipedal orthograde progression as what might be termed a toddler, somewhat after the fashion followed in some degree by the bears."

I apologize for the length of quotation but I have thought it wise that the reader should draw his own conclusions. It may be that I am incorrect in thinking that Professor Wood Jones had forsaken his tarsian hypothesis. This may be so but there can be no doubt that he was extremely critical of his previous thoughts, and his attitude of mind had become increasingly Hunterian in its later stages—" function is the creator of structure and not its offspring."

It has indeed been a refreshing pastime to refer to the works of Professor Wood Jones. I have found this a great contrast to the persistent degree of monotony caused by the ceaseless repetition of threadbare neo-Darwinian arguments. The story has been told and retold on countless occasions, and to such an extent that what began with a simple hypothesis now resides amongst us as a firm belief. We are spared this monotony now-a-days by a few experts, in various branches of science, who are placing before us some new thoughts. I have already referred to the book published recently (1958) by Professor Graham Cannon ; I have already commended this work to the reader, as I should like to do also the most recent publication of Professor Waddington, one of a number of authors contributing to *A Century of Darwin* (1958). Another of these authors is Professor Romer, Director of the Museum of Comparative Zoology at Harvard University, but I should prefer to quote from his book *The Vertebrate Body* (1950) : " The almost complete separation of form and function prevalent in instruction today is both unnatural and unfortunate. It is doubtful if there is such a thing as a non-functioning structure, although mention of function is often taboo in morphological works."

In 1916 Dr. E. S. Russell published a book named *Form and Function.* On the first page of the preface you will find the following " Is function the mechanical result of form, or is form merely the manifestation of function or activity ? What is the essence of life-organization or activity." I have been given to understand, on very good authority, that Dr. Russell and Professor Wood Jones frequently discussed many problems. The

works of these two men had much in common and perhaps we m.ght conclude with a brief discussion on the relation of form and functio...

If we could abolish from our mind the word archetype I believe we could make some advance. This term is more applicable to some skeletal remains imprinted upon the rocks or some skeletal form preserved in some museum. If instead we could visualise the ingredients that are responsible for the organism, the parts not contained in the rocks or usually demonstrated in the museum we could then pick out some hallmarks that might be said to be significant of a particular beast or group of beasts, be this structure or function. In my own mind I have attempted to depict function and form as an interwoven complex containing two basal ingredients—the basal form and the basal function. These two basal ingredients combine to produce the various specializations in the succeeding generations. In the first instance there must be a form of sorts and it is upon this primitive form that the primitive mechanism works and results in the perfecting of the machine. The issue is not quite as simple as this since in the course of the animal's phylogenetic history nature may supply new parts and correspondingly the function may need some adjustments. On the other hand the worn-out parts may not be replaced and the machine will have to do as best it can under the circumstances. The employment of the phrase "use and disuse" must always be tempered with the basal form and this brings to mind the maimed or mutilated animals. Certain big structural differences have occurred at various times and one of the most interesting of these changes is the means of transport employed by the vertebrate animals. The means of transport in the sea, in the air and on the land all require certain basal ingredients. The birds may fly, or remain on land or water by virtue of the fact that there is not the basic form required for the basic function to transport them into the air. On the other hand the argument could be put forward that through disuse these wings became vestigial.

The next problem that confronts us is probably the greatest of all—does the organism evolve as a complete unit, or are the parts allowed freedom, and therefore free to evolve independent of the whole? The Simian hypothesis is popular because, taken as a completed entity, the anthropoid ape is more akin to man than any other beast. Very simply the problem is an enquiry as to whether nature works as a nationalised industry or whether she supports the doctrine of free enterprise. We have arrived back at the stage of enquiring what are the " Hallmarks of Mankind ? " I have the temerity to suggest that in dealing with any organism we have the "*fixtures*"—the furnishings that are there permanently—and the " removable fixtures " or the " soft furnishings " that come and go with every tenant. What do I mean by this statement? Every beast must have a means of transport—Nature has decreed that this shall be on all fours on terra firma, on four hands in the arboreum, or two wings in the air, etc. The machine then has four feet, four hands or two wings, etc.

and these are the " fixtures." The " soft furnishings " come with the claw, the hoof, be it cloven or solid etc. Upon this hypothesis rests the view that in the reptilian stage there is a degree of uncertainty as to transport of the future generations. It could be argued that the orders of the day are four limbs to work in unison or on the other hand a separation of function between the fore and hind limbs. The true quadrupedal has been given the makings of four limbs for the hoof, the claw, or the arboreal habit in distinction from the bird that has been unable to use its hind limbs for flight, and the marsupial relying on its hind limbs akin to certain of the dinosaurs. The choice rests with each individual as to whether he sees in the animal a uniformity in the unfolding process or a diversity of structure and of necessity a diversity of function which is independent of the whole. The choice rests with the individual in deciding the hallmark of Man as to whether he attaches primary or secondary importance to vertical posture. The basal ingredients that go to form the cake are limited and few for essential needs. The ingredients over and above this are added to produce different kinds of cakes—they are the specializations or secondary ingredients. We must enquire if one of the basal ingredients in man is his transport mechanism—does he come from primitive limb structure which has graduated from all fours? Some birds failed to fly possibly on account of the failure to develop the basal structure necessary for the wing and they remained on the ground. Is the cursorial habit of the Ratites a primary phenomena? Is the saltatory habit of the marsupials a primary phenomena? I believe it is so. Is the orthograde posture of the bear a secondary phenomena? I believe it is so. Is man's orthograde posture a primary characteristic or is it a secondary via the arboreum? If you are inclined to the view of unity in the organism together with the formal morphological approach you will decide that it is a secondary feature. If you attach more importance to functional morphology and the freedom of the organism's decentralized plan you will be inclined to view it as a primary feature and one of " The Hallmarks of Mankind."

I must hasten to acknowledge the great deal of help given in the preparation of this paper by Miss Jessie Dobson ; for her advice on many occasions I am most grateful.

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BIRTHDAY HONOURS

IN THE BIRTHDAY Honours List, H.M. The Queen graciously conferred the following honours on Fellows and Members of the College :

K.C.V.O.	SIR ARCHIBALD M. H. GRAY, C.B.E., T.D., F.R.C.S.
	W. P. H. SHELDON, C.V.O., M.R.C.S.
K.B.E. (Military Division)	F. W. P. DIXON, C.B.E., F.R.C.S.
C.B. (Military Division)	P. J. L. CAPON, M.R.C.S.
C.V.O.	R. W. L. MAY, M.R.C.S.
C.B.E. (Civil Division)	MRS. E. L. G. HILTON, F.R.C.S.
	W. A. GLYNN, M.R.C.S.
	A. J. HAWE, O.B.E., M.R.C.S.
	MISS M. W. WARREN, M.R.C.S.
M.V.O. (4th Class)	G. F. CAREY, M.R.C.S.
	A. P. M. NICOL, M.R.C.S.
O.B.E. (Military Division)	E. B. MARTIN, M.R.C.S.
O.B.E. (Civil Division)	J. S. R. GOLDING, F.R.C.S.
	V. WILKINSON, F.R.C.S.
	L. C. COOK, M.R.C.S.
	W. E. DORNAN, M.R.C.S.
	J. A. DURANTE, M.R.C.S.
	E. A. HARDY, M.R.C.S.
	MRS. D. L. OFFICER, M.R.C.S.
M.B.E. (Civil Division)	C. G. HARPER

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PERMANENT INTUBATION IN INOPERABLE CANCER OF THE OESOPHAGUS AND CARDIA

A new tube

L. R. Celestin, F.R.C.S.Ed.

Department of Surgery, Postgraduate Medical School, Hammersmith Hospital

HISTORICAL BACKGROUND

ENDO-OESOPHAGEAL INTUBATION OF malignant strictures has been practised for over a century. As early as 1845 Leroy d'Etiolles was using decalcified ivory to make short tubes that would tunnel through a growth. His attempts, however, were not successful. In this country Sir Morrell Mackenzie was amongst the first to toy with a similar idea, but it was left to Sir Charters Symonds to record the first success in 1885. He was opposed to the use of long tubes (not unlike our present-day Ryle's tube) as recommended by Croft, Durham and Krishaber. Instead he used a six-inch length of No. 10 oesophageal tube which he fixed to a boxwood funnel by German silver wire. Later he used ivory and silver instead of boxwood ; and eventually had the tube and funnel made as one in gum elastic. He got over the difficulty of retaining the tube in position by hanging it from a silk thread that was brought out through the mouth or nose and fixed to the ear by strapping. An illustration of his first tube *in situ* in the autopsy specimen is shown in Figure 1.

Symonds's method remained forgotten until revived by Sir Henry Souttar in 1924. In the meantime, in 1914, Guisez suggested the use of a De Pezzer-like catheter for oesophageal intubation. The catheter was 6 cms. long, ended blindly and carried side holes. It was stretched over an introducer, thus narrowing its external diameter and making it easier to navigate the stricture. Once in position the introducer was removed, the catheter being gripped tightly by the stricture. Until Guisez described this technique, tubes had been inserted blindly. Guisez made full use of the oesophagoscope and of bougies ; and the method appears to have been very safe in his hands.

Like Guisez, Sir Henry Souttar used direct vision and a special introducer to insert his coiled metallic tubes. They carried a funnel-like top, which he sometimes reinforced by using a wider funnel made of rubber. The method yielded satisfactory results, but tubes were often passed, and false passages were always a danger. To minimize this danger Resano modified Souttar's technique and used a guide to direct the tubes. In Resano's hands the immediate mortality from intubation was as low as 5 per cent.

Resano's work came with the postwar surge of interest in surgery of the oesophagus. Brown in the United States had already recommended the use of a silver tube in 1949, but this was quickly superseded by tubes fashioned from modern synthetic materials. In 1954 Coyas of Athens

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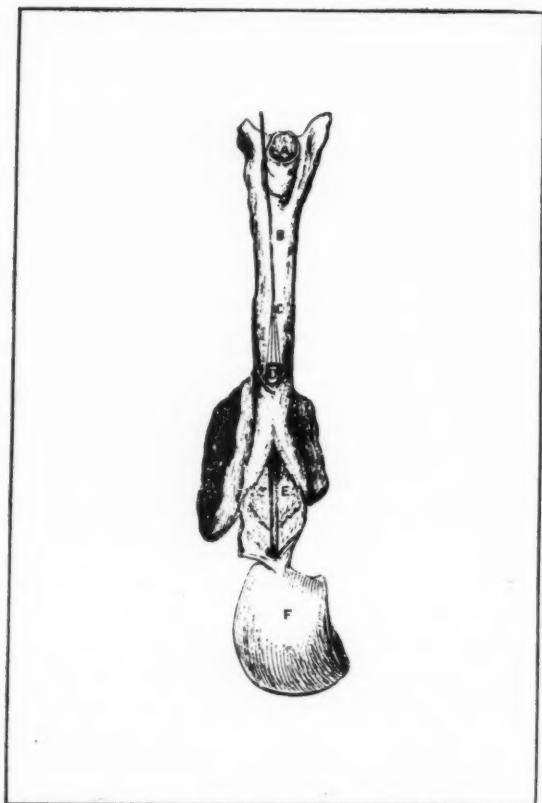
To illustrate Mr. Charters J. Symonds's Œsophageal Tube *in sitû*.

A. Upper aperture of larynx.
B. Œsophagus laid open.
C. Silk thread by which the tube is retained in position.
D. Wide upper end of the tube above the stricture.
E. Narrower lower part of tube below the stricture.
F. Cardiac end of stomach.

Fig. 1. Symonds's tube.
(Reproduced by kind permission of Longmans Green & Co.)

working conjointly with Triboulet-Piton in France described a plastic tube (with a metal ring at each end to make it radio-visible) with no funnel to it, but carrying parallel rings that would be gripped by the tumour. The tube is inserted under direct vision using a large oesophagoscope. The same year Kropff described a funnel-carrying polythene tube which

is introduced via a cervical oesophagotomy. Barbin subsequently modified Kropff's tube and adopted a novel technique in intubation.

"Push" and "pull" methods

Until then all tubes had been inserted by the " push " methods, either blindly or through an oesophagoscope. Mousseau and Barbin use what is fundamentally a " pull " method. Their tube (Fig. 2) is inserted by threading the catheter-like portion blindly down the oesophagus. If necessary a flexible introducer can be passed down it and withdrawn once it is in the stomach. A high gastrotomy is made, the catheter is recovered and the tube is drawn down the oesophagus by pulling on the former until the funnel is felt to engage the stricture. The excess of catheter and tube is then cut off. This " pull " method would appear to be safer than the earlier " push " method. The Mousseau-Barbin tube, like all its predecessors, is circular ; it is made of Neoplex and for a given lumen has thicker walls than have metal tubes—hence a lesser flow through it, size for size.

All tubes carrying a circular funnel have the disadvantage that an oedematous ring may form above the funnel and lead to obstruction or to ulceration. Furthermore the distended oesophagus has an oval lumen which is more likely to tolerate an oval structure with greater ease than it does a circular one. Bearing these points in mind, as well as the advisability of intubing the stricture under direct vision, a new tube has been devised. It is in two parts (Fig. 3) :

1. An endo-oesophageal tube.
2. A pilot bougie.

The new tube

The tube is made of natural polythene, is *oval* in its various diameters, and carries a thin, soft *barrel-shaped* funnel. This means that the oesophageal walls do not part from it at an angle (as they do in an ordinary V-shaped funnel) ; instead they surround intimately the gentle curvature of the upper end of the funnel. The latter is 5 cms. long with an opening 18 mm. × 22 mm., while the tube proper is 25 cms. long, has a lumen of 30 F. and can be cut easily at any desired length in spite of its fairly firm though flexible walls, 1 mm. in thickness.

The pilot-bougie, 60 cms. long, size 14 F., is made of solid polythene and has the consistence of gum elastic. It carries an inverted conical end which plugs into the tube and can be secured to it by a length of silk threaded through the holes provided. The silk should be left some 50 cms. long in case the tube has to be pulled up if insertion fails.

Method of use

Under direct vision, with the use of a small size oesophagoscope, the bougie is piloted through the stricture, which may sometimes require dilatation beforehand. A sufficient length is passed down the oesophagus
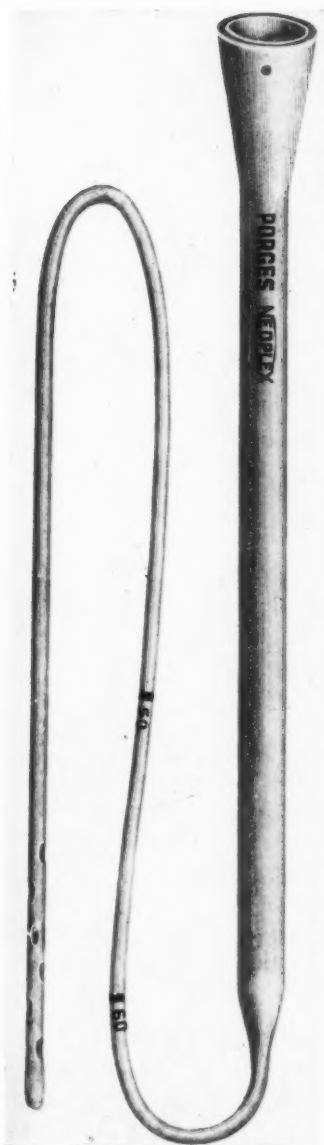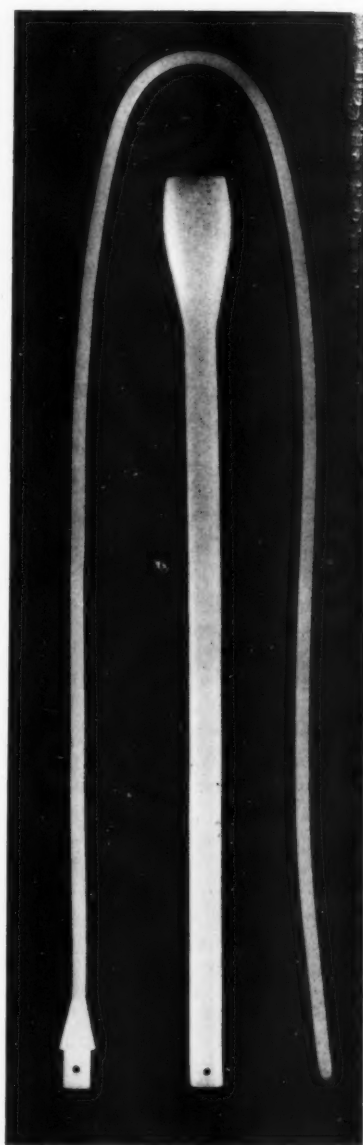
Fig. 2. The Mousseau-Barbin tube.   Fig. 3. The new tube.
(Reproduced by Courtesy of Porges)

so that the bougie reaches the stomach. The oesophagoscope is then withdrawn over the bougie. The tube is then plugged on to it and made secure, the length of silk hanging loosely outside. A high gastrotomy is made and the lower end of the bougie is recovered. It is gently pulled down. The cone will be felt engaging the stricture. At this stage traction must be steady and very gentle until the entire tube has traversed the stricture and a resistance is met as the funnel reaches the growth and is held back by it. Intubation is then complete. The silk thread is cut and the bougie is disengaged from the tube. If the latter is held tightly by the growth it can be made to descend slightly further into the stomach by over traction, to be then cut flush with the cardia and allowed to retract up into the oesophagus. When the malignant stricture does not appear to grip the funnel tightly enough, or in carcinoma of the cardia, the lower end of the tube should be bevelled generously and then anchored to the lip of the gastrotomy by a through-and-through braided nylon suture. The gastrotomy is then closed by two inverting layers of sutures. By means of this simple procedure the tube is prevented from slipping down and being passed. It is advisable for the patient to sleep with the head and shoulders elevated.

Patients with such tubes can eat anything provided they masticate their food thoroughly. Tablets and capsules should be avoided. Sips of water taken now and then during a meal assist the passage of solids. Before and after meals the tube is cleansed by drinking soda water or any " fizzy " drink.

Results so far are gratifying in as much as the patients are not aware of the presence of the tube, can enjoy the normal pleasures of taste, and do not feel they are dying of inanition. But, as already pointed out by Professor Lortat-Jacob, these tubes must not be used as a short-cut to surgery. They are essentially meant for the inoperable, and should not be misused.

ACKNOWLEDGMENTS

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APPOINTMENT OF FELLOWS AND MEMBERS
TO CONSULTANT POSTS

W. N. ROLLASON, M.B., M.R.C.S., F.F.A.R.C.S. Lecturer in Anaesthetics, University of Aberdeen ; Consultant Anaesthetist to North Eastern Regional Hospital Board, Scotland.

M. J. JOSHI, F.R.C.S. Honorary Assistant Surgeon to Sassoon Hospital ; Honorary Lecturer to B.J. Medical College, Poona.

W. K. DOUGLAS. M.A., M.B., F.R.C.S. Consultant Thoracic Surgeon to South Manchester and West Manchester Groups of Hospitals.

A. H. BARBER, M.A., M.B., M.R.C.P., F.R.C.S. Consultant Obstetrician Gynaecologist to Oldham and District Group of Hospitals.

P. C. LEESON, M.B., B.S., F.R.C.S. Consultant E.N.T. Surgeon to Salford and West Manchester Groups of Hospitals.

I.K.R. McMILLAN, M.A., M.B., F.R.C.S. Consultant Thoracic Surgeon to Cardiac and Thoracic Unit of Wessex Regional Hospital Board, Southampton Chest Hospital

N. R. NARAYAN, F.R.C.S. Honorary Surgeon to Bowring and Lady Curzon Hospitals, Bangalore.

G. SINH, F.R.C.S. Honorary Assistant Neuro-Surgeon to J.J. Group of Hospitals, Bombay.

J. C. N. JOSHIPURA, F.R.C.S. Honorary Assistant Orthopaedic Surgeon to J.J. Group of Hospitals, Children's Orthopaedic Hospital, and Sir H. N. Hospital, Bombay.

D. C. PATEL, M.S., F.R.C.S. Honorary Assistant Surgeon to J.J. Group of Hospitals, Bombay.

J. S. J. MORLEY, F.R.C.S., F.R.A.C.S. Assistant Orthopaedic Surgeon to Royal Melbourne Children's Hospital.

A. H. C. RATCLIFF, M.B., Ch.B., F.R.C.S. Consultant Orthopaedic Surgeon to Southend-on-Sea Hospital Group.

The Editor is always glad to receive details of new appointments obtained by Fellows and Members, either through the Hospital Boards or direct.

ANATOMICAL MUSEUM

THE SPECIAL DISPLAY for the month of September consists of Hunterian specimens illustrating the normal development of human foetus.

THE ANATOMY OF THOMAS GEMINUS
## A Notable Acquisition for the Library

By

Geoffrey Keynes, Kt., M.D., D.Litt., F.R.C.P., F.R.C.S., F.R.C.O.G.

Honorary Librarian of the College

De humani corporis fabrica, the famous anatomy book by Andreas Vesalius, was published in Basel as a large folio in 1543. A second edition was published twelve years later, in 1555, but already in 1546 Vesalius was complaining in the course of his *China Root Epistle* that his book was being plagiarised in England, " where the figures of my *Epitome* have been copied very poorly and without skill in drawing—although not without expense to whomever will have to pay for them." The *Epitome* of Vesalius's *Fabrica*, first published in 1543, was a greatly abbreviated form of the folio—a dissecting room edition as it were, with nine of the the splendid figures slightly enlarged and accompanied only by a brief description. It was this *Epitome* that had been adapted, to the annoyance of Vesalius, for the English market by an enterprising publisher under the name Thomas Geminus. This pirated work contained forty engraved copper-plates copied from the wood engravings of the *Fabrica*, preceded by an engraved title-page containing the arms of Henry VIII and with a large folding plate of nude male and female figures also copied from the *Epitome*. The accompanying text is derived from the *Epitome*, the title given to the piracy being : *Compendiosa totius Anatomie delineatio aere exarata*. The plates, notwithstanding the criticisms of Vesalius, are executed with considerable skill, though they were the first copper-plate engravings ever to be executed and printed in England.

Geminus was formerly thought to have been an Italian named Gemini, but he has recently (*Brit. med. J.* 1953 **2**, 150) been identified with a Flemish refugee, Thomas Lambrit or Lambert. This man began his career as a publisher in England by collaborating with Thomas Raynald in producing *The byrth of Mankinde, otherwise named the Womans booke* in 1545. The *Compendiosa totius Anatomie delineatio* also appeared in 1545, having been printed for Geminus by John Herford. This enterprise was successful, and it is suggested in Harvey Cushing's *Bio-bibliography of Vesalius*, 1943, that it was Dr. John Caius who persuaded Geminus to follow it up by publishing his anatomy book in English. This has not been confirmed by the researches of Professor C. D. O'Malley in his study of Geminus recently published : O'Malley points out that Geminus himself claims to have been commissioned to produce these copper-plates by King Henry VIII. The publisher used the same engraved title-page as before with the date, 1553, added after the imprint. According to his preface he called in Nicholas Udall, a well known scholar and former head master of Eton College, to make a translation. In fact, however, Udall translated only the *Characterum indices* and contributed a short address

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Quinta musculorum tabula.
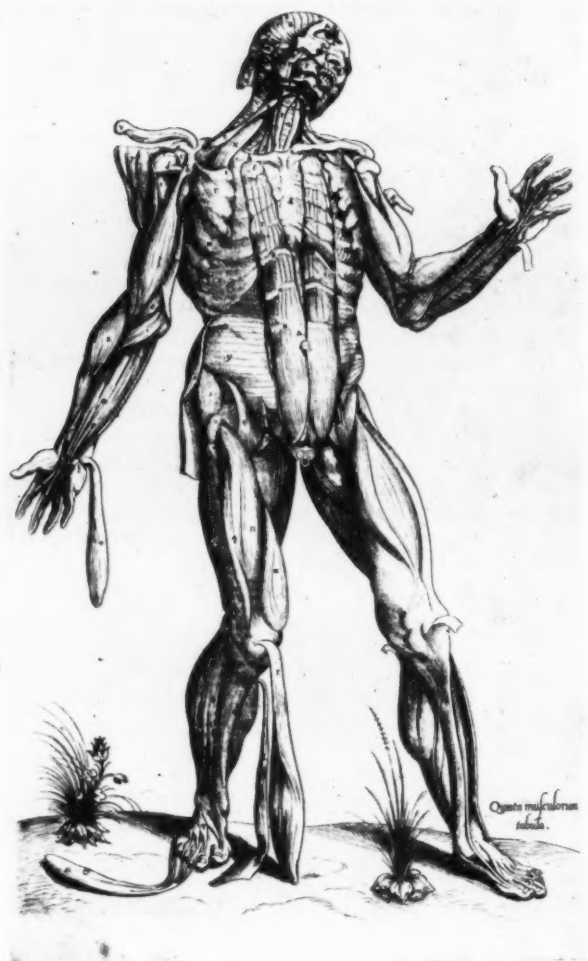
" To the ientill readers and Surgeons of England ". The text of the book
was not a translation of the Latin Geminus. It was printed by " Nycholas
Hyll dwellynge in Saynte John's Street," and was similar to that used by
Thomas Vicary in his *Anatomie of the bodie of man*, 1548, this having been
translated from an earlier manuscript by Henri de Mondeville (d. 1320).
The English Geminus was, therefore, virtually a new book, combining
Vesalian illustrations with a version of an early text by a Frenchman

Decima tertia
musculorum tabula.
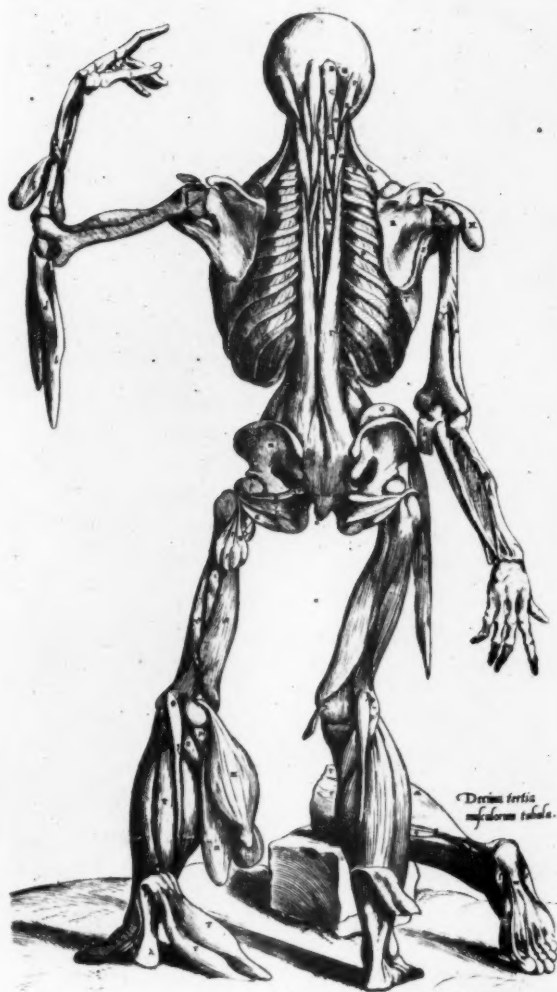
rearranged to follow the order of the *Anatomia* of Mondino, 1478.   The
Latin Geminus of 1545 and the English edition of 1553 were the first
illustrated text books of anatomy to be published in this country and the
forty illustrations were printed from the first copper-plates to be executed
here.

This brief account of the *Compendiosa delineatio* of Thomas Gemin us, distilled mainly from the pages of Cushing's *Bio-bibliography of Vesal us*, is concerned with a series of the rarest and most valuable anatomical ext books that are known. The library of the Royal College of Surge ns was already provided with several of them, namely the *Fabrica* of 1543 and 1555, the *Epitome* of 1543 (acquired by purchase only in 1949) and the Latin Geminus of 1545. By great good fortune the College has now (May 1959) been able to acquire the rarest of them all, the English Geminus of 1553. Cushing records seven copies, five of which are in the United States of America and two in England. The English copies are in the British Museum and in the Wellcome Historical Medical Library, though this one is a variant issue without a date on the title-page. Three others, unrecorded by Cushing, are in the Bodleian Library, Oxford (with undated title-page), William Hunter's Library at the University of Glasgow, and Leeds University Library. Mr. W. R. LeFanu informs me that only two incomplete copies have appeared in the London sale rooms since 1902, when records of sales were first published. The copy now in the library of the College was acquired through the good offices of Sir Hugh Lett from the estate of the late William Henry Newton, M.R.C.S., of Walmer, who died in December 1958. Like several other copies, it lacks the folding plate of the nude figures known as " Adam and Eve." In the *Epitome* of Vesalius the male figure holds a skull in his left hand : in the Geminus plate an apple is substituted for the skull, which is now depicted on the ground between the figures with a serpent issuing from the *foramen ovale*. Other lesser defects are the loss of the lower outer corner of the engraved title-page and the absence of one leaf (signature I 5) with duplication of the succeeding leaf, this being an original binder's error. The book possesses, however, the very unusual virtue of still having its original English calf binding decorated with panels blind-stamped with rolls in three tiers*. Gilt tooling was not yet being done in England in 1553. The volume is, in fact, in the state known to bibliographers as " unsophis-cated," and the minimum of repairs has been executed by John Gray and Son of Cambridge.

The earlier history of the volume is not known nor through what channels it came into the possession of Dr. Newton. The fly-leaf before the title-page carries, however, a most interesting record in the form of a nearly contemporary (1609) doctor's register of his patients with their complaints and treatments. This will be transcribed and published later.

Opportunities of acquiring books of this quality are few indeed, and the College is greatly indebted to Sir Hugh Lett for his kindness in arrang-ing the purchase.

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* Two of these rolls are to be identified in Oldham's *English Blind-stamped Bindings*, Cambridge 1952, as : (I) at the edges, No. 635, FC.h.(4) ; (II) in the median position, No. 786, HM.a.(17). (III) In the innermost position is a roll which Mr. Oldham tells us is unknown to him and hitherto unrecorded ; it resembles, but with considerable variation, his No. 849, HM.h.(24).

Bibliographical description

GEMINUS.   Anatomy, English edition, London 1553.

Engraved title: COMPENDIOSA / totius Anatomie delineatio, aere / exarata : per Thomam Geminum. / LONDINI.   1553.

Colophon: Imprynted at London by Nycholas Hyll dwellynge / in Saynte Johns streate, for Thomas Geminus.

Collation: fo. [*]$_2$, A$_6$, B$_7$, C-I$_6$, K$_2$; 59 leaves, 40 plates ;   390 × 285 mm.   The leaves are not paginated, and the plates not numbered continuously.

Contents: [*]$_1$a engraved title ;   [*]$_1$b blank ;   [*]$_2$a dedication to King ' Edwarde the VI ' [who died 6 July 1552] ; [*]$_2$b Epistle by the translator, Nicholas Udall, ' To the ientill readers and Surgeons of Englande ', dated ' Windesore, 20 July 1552 ' [that is, a fortnight after the death of the King to whom the book is dedicated] ; A$_1$a-K$_2$a text of ' treatyse of Anatomie ' ; the plates are inserted through the text.

Note: This copy lacks leaf I$_5$, but has I$_6$ in duplicate ; plate [25], before F$_4$, is in the second state ; the folding plate following B$_2$ is wanting.

Leaf I$_5$ has now been supplied from another, fragmentary, copy of the book.

INTERNATIONAL FEDERATION OF SURGICAL COLLEGES

A MEETING OF the International Federation of Surgical Colleges was held in Munich on 15th and 16th September, under the chairmanship of Sir Harry Platt, Bt., F.R.C.S.

Working parties were set up to examine the following problems with which the Federation proposes to concern itself :
(*a*) Surgical Missions
(*b*) Training of Surgeons
(*c*) Surgical Research
(*d*) The interchange of Young Surgeons

The following new members were elected : College of Surgeons of Poland, Association of Surgeons of India, Association Française de Chirurgie, Societe Hellenique de Chirurgie, Austrian Surgical Society, Swiss Surgical Association.

The representative of the Polish College of Surgeons was elected to fill a vacancy on the Executive Committee.

An open meeting was held, at which papers were read on the topic *International cooperation by means of sending surgical missions to countries in need of them.* A report of this meeting will be published at a later date.

It was agreed to hold the next meeting of the Federation in London in October, 1960.

JOHN HUNTER'S VIEWS ON CANCER

JESSIE DOBSON, B.A., M.Sc.
Curator of the Anatomy Museum, Royal College of Surgeons of England

IN ESTIMATING HUNTER'S contribution to an understanding of this disease, it must first be decided what was generally known at the time. Galen believed that it was caused by a superfluity of black bile ; and that its name was due to the similarity of the shape of the tumour to the crab. Even in this period complete extirpation of breast cancers was practised and where this was not possible the treatment usually consisted of the application of a poison as being the best method of counteracting a poison. Belladonna and hemlock were the most popular remedies but many of the metals were also used. Galen's " humoral theory " was accepted without question for over a thousand years ; even Guy de Chauliac and Jean Fernal found little fault with it. It was the Paris surgeon, Henry François Le Dran (1685-1770) who introduced the idea that it was a local lesion, spreading along the lymphatic vessels to the regional lymph nodes ; and Percivall Pott (1714-1788) was the first to suggest an occupational cause for the disease. In the second half of the eighteenth century, therefore, some attempt had been made to ascertain diagnostic signs ; and the questions of heredity, contagiousness, climate and locality had been considered.

When discussing diseases in general, Hunter remarks that there are three types of " unnatural dispositions "—first, where speedy restoration to the normal is assured ; secondly, where the indisposition arises from necessity, such as thickening of parts from pressure ; and thirdly, where the diseased disposition is more lasting. He suggested that every disease has an allotted time for action and, he says, " in cancer it is often very tedious."

Definition

His main discussion of cancer occurs in his *Lectures on the Principles of Surgery* and he describes it thus : " I would call that cancer which produces the following effects : viz, a circumscribed tumefaction with much hardness, and a drawing in of the skin covering it, as if the cellular membrane underneath it was destroyed ; then a species of suppuration takes place in the centre and ulceration of the external surface . . . Cancer is one of the first class of our first division of poisons, viz, that which only produces local effects, though it has been supposed to contaminate the constitution ; which would be terrible, indeed, as we have no specific nor even a palliative for it."

Site

" It most commonly attacks the conglomerate glands, and first the female breast ; also the uterus, the lips, the external nose, the pancreas, and the pylorus ; besides which the testicle is very subject to it, though that is not to be classed among the conglomerate glands . . . When I

speak of cancer, I mean a peculiar disease in some of the above parts. There is another disease which is also called cancer, which I have called fungated ulcer."

Diagnosis

Hunter mentions that it is sometimes difficult to make a differential diagnosis, particularly when it and another similar affection may be found in the same site. Scrofula is such a disease and Hunter remarks that " When small, they probably cannot be distinguished ; but as they increase, the distinction is more easy. If cancer, it will vary its appearance by becoming less circumscribed, not having so determined an outline, from the cellular membrane around becoming diseased ; the skin will be less moveable, the nipple more or less retracted, and the lymphatic glands going to the axilla will swell. But in scrofula there will be no surrounding disease, no affection of the nipple or axillary glands, no adhesion even though the tumour be large . . . When scrofulous tumours are large, and become slightly inflamed, they get more diffused, and put on a greater resemblance to cancer ; but in cancer the inflammation comes on earlier and goes on with the disease . . . the surrounding parts that are affected by continued sympathy also become cancerous near the skin, that is, all the parts become blended in one mass ; but in scrofula, although the surrounding parts are in action, yet that action is not so scrofulous as the part itself ; so that the skin will sometimes heal over the scrofulous tumour."

Hunter believed that cancer was a local lesion, and he wondered, in fact, whether it produced any effect on the constitution. He was well aware of the opinions of others—that after operation, or even without operation, the condition would arise in another part of the body, which appeared to show that it was " an act of the constitution and that by closing one outlet another has to be made to drain off the poison."

Mode of contamination

" A scirrhus or cancer," he says, " appears to have three modes of contaminating ; first by continued sympathy, which is common to other diseases ; second by remote sympathy, which is peculiar to itself ; third by contact or communication of its matter to other parts by contamination. I have called these consequent cancers, in opposition to the original."

Cause and incidence

" It has been said that cancers are produced by ill health, as rheumatisms are ; but this arises from the age of cancer being the age of such complaints and being thus the predisposing cause of both, but not particularly of the cancerous disposition. The predisposing causes are three in number, viz., age, parts and hereditary disposition ; perhaps climate also has consider-able effect, though not itself a predisposing cause. The cancerous age is

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from forty to sixty in both sexes, though it may occur sooner or later in certain cases. When cancer occurs in the breast of women under forty it is more rapid in its progress than when the patient is older and also more extensive; remote sympathy likewise takes place more readily in them than in the old, so that the operation succeeds better in the latter on this account. However, we seldom find it in the young or very old; though of the two it is most frequent in the latter. When it occurs in the young, does it not show a very strong disposition for the disease and therefore more danger, from a greater likelihood of its returning?"

Whether hereditary

" Some suppose cancers to be hereditary; but this I can only admit according to my principles of hereditary right; that is, supposing a person to possess a strong disposition or susceptibility for a particular disease, the children may also, but I have not yet ascertained the generality of this fact. In many persons it would appear that some of the predisposing causes are sufficient to become the immediate ones; as when the diseased action takes place at a certain stated time, without any immediate cause. Are they more frequent in one country than another? I have heard they are very rare in the West Indies; and they do not seem to be frequent in the Friendly Islands . . . and so most probably climate has some power both in disposing to the disease and in preventing it."

Of the treatment

" No cure has yet been found." Hunter wrote these words about a hundred and eighty years ago; and the statement is still undisputed. " What I call a cure," he says, " is an alteration of the disposition and the effect of that disposition and not the destruction of the cancerous parts. But as we have no such medicine, we are often obliged to remove cancerous parts; which extirpation, however, will often cure as well as we could do by changing the disposition and action." Of the use of arsenic, one of the popular remedies of the time, he remarks that " it is very dangerous and I am afraid insufficient for the disease. This is a remedy which enters into the empirical nostrums which are in vogue for curing cancer; and among which Plunkett's holds the highest rank. But this is no new discovery, for Sennertus, who lived the Lord knows how long ago, mentions a Roderiguez and Flusius who obtained considerable fame and fortune by such a composition." This was Daniel Sennert (1572-1637), one of the most famous physicians of the seventeenth century, born in Breslau and Professor of Medicine at Wittenberg for thirty-five years. He survived six epidemics of the plague and was a victim of the seventh.

" I was desired to meet Mr. Plunkett," remarks Hunter, " to decide on the propriety of using his medicine in a particular case; I have no objection to meet anybody; it was the young one; the old one is dead and might have died himself of a cancer for aught I know. I asked him what

he intended to do with his medicine. He said ' To cure the patient.'
' Let me know what you mean by that : do you mean to alter the diseased
state of the parts ? or do you mean by your medicine to remove the parts
diseased ' ' I mean to destroy them,' he replied. ' Well then, that is
nothing more than I or any other surgeon can do with less pain to the
patient.' "

The Plunkett family had been dispensing cures for cancer for nearly a
century at this time. " The young one " that Hunter mentions died
probably in the early 1770s and the business was then carried on by his
wife at Curzon Street, Mayfair. After her death in 1776, her daughter
took it over, married a Dr. Reilly, and seems to have sold it to a Mr.
Connor, an army surgeon, in 1785. Richard Guy in his " Essay on
Scirrhous Tumours and Cancers " published in 1759, says that he had
purchased this " secret remedy " from the older Plunkett. Hunter gives
the recipe for the " cure " so presumably Guy had not kept it secret as its
inventor had done. It was as follows : crowsfoot, 3 drachms and 2
scruples ; dogfennel dried, 1 drachm ; crude sulphur, 2 drachms and a
half ; white arsenic, 5 drachms ; beat in a mortar, and form into a powder ;
one or two drachms of which are to be mixed with the yolk of an egg
and being spread on a piece of bladder to be applied so as to cover the sore.
Arsenic alone, he gives warning, would produce too violent an inflam-
mation and destroy the sound parts by mortification.

Hunter apparently did not think too badly of Plunkett's plaister ; but
he had little time for most of the cancer curers. " Poor Woollett the
engraver," he says, " died under one of these ; he was under my care when
this person took him in hand. He had been a life-guardsman, I think, and
had got a never-failing receipt. I continued to call on Woollett as a friend
and received great accounts of the good effects, upon hearing which, I
said if the man would give me leave to watch regularly the appearance of
the cancer and see myself the good effects and should be satisfied of its
curing only that cancer (mind, not by destroying it) I would exert all my
power to make him the richest man in the kingdom. But he would have
nothing to do with me and tortured poor Woollett for some time ; till at
last I heard the sound testicle was gone and at length he died." William
Woollett was born on 10th August 1735 at Maidstone, and he resided for
a time in Green Street, Leicester Square, afterwards moving to Charlotte
Street, Rathbone Place. His most famous work was an engraving of
West's " Death of General Wolfe " and this earned him the title of His-
torical Engraver to His Majesty. He died on 23rd May 1785 after great
suffering and was buried in Old St. Pancras churchyard.

Hunter favoured extirpation wherever possible for, he says, " with the
knife we can go where the other cannot reach ;" but it must be decided
" whether the whole disease can be safely extirpated ; if so, the operation
is proper . . . Great attention should be paid to the tumour, whether it
is moveable or not, for as the disease is further extended so the parts are

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more united to the tumour. If the tumour is not only moveable but the part naturally so, then there is no impropriety in removing it . . . if any consequent cancers easy of extirpation are found, they may safely be removed also. But it requires very great caution to know if any of these consequent tumours are within proper reach for we are apt to be deceived in regard to the lymphatic glands which often appear moveable when, on extirpation, a chain of them is found to run far beyond out of our reach which renders the operation unsuccessful. As this is not easily known, I would, in most cases, where the lymphatic glands are considerably enlarged, advise that the case should be let alone. We cannot be too nice in our examination, nor often too rough-handed in the operation. In cases where the original and consequent tumours are circumscribed, and sufficiently moveable, the operation has generally been successful, being nothing more than a common wound."

The importance of removing the " whole disease " is greatly stressed ; for if this is not done " the sore either does not heal, or if it does, the cicatrix breaks out again ; so likewise if the surrounding contaminated parts are not removed, although the whole original disease is, then, some months after, there will be a new ulceration there. After the visible disease is removed, we should minutely examine the sore so as to feel and press every part, and if anything is hard or irregular, remove it. After operating in the axilla, we should introduce the finger into it, in order to discover if any of the other glands are affected ; and before the part is dressed the tumour itself should be inspected to see if there are any corresponding appearances so as to lead to the supposition of a part being left. Having once had the misfortune to leave a part, I let it go on for a few days, when the sore granulated healthily all over, except at that part, which had a bluish appearance and discharged a dark-coloured matter. I then dissected that bit only, and the patient recovered.

Hunter mentions this particular case in his records and comments upon it as follows : " I considered that the bad success arising from amputation of the breast arose from not taking away enough. I was resolved to take away much more than seemed necessary. I removed then at once all that seemed diseased and along with it near an inch thick of fat, etc., but at one part a process or root seemed to extend beyond the tumour which I did not know until all was over and which I only knew by examining the tumour that was extracted. When I dressed it next morning I put the extracted tumour into the wound to find out the corresponding parts but could not observe any hardness opposite the hard surface of the tumour. A fortnight after a further part was extracted which was the missing part."

Towards the end of his remarks upon cancer, Hunter makes the following comment : " It is surprising to see how a young man, if he catches an idea which has any novelty will write away on it and tell you wonders. Thus, Mr. Fearon has lately recommended healing by the first intention in this disease, which is the last thing to be thought of, as we have here only

in view the total removal of the disease and not the healing of the wounds. But no man should write a book without taking every circumstance of the disease into consideration ; he should not write from a single idea, which many circumstances may render futile. I have used this plan in small circumscribed cases in the breast, where there was very much skin, although I have been very liberal of my removal at the same time."

This work of Henry Fearon, *A Treatise on Cancers with a new and scientific method of Operating*, was published in 1784. The author had gained his Diploma from the Company of Surgeons on 1st May 1777, in which year the Surrey Dispensary was opened to which institution he acted as Surgeon and Accoucheur until his death in May 1803. In this treatise he says : " In most cancers (those of the breast especially) internal ulceration takes place long before the skin shews any tendency to ulceration so that every hope and opportunity of cure may be lost and the patient destroyed by the deep and latent progress of the disease, without external ulceration ever taking place. This circumstance, therefore, of internal ulceration taking place so soon, not having been sufficiently attended to by any author I have read on the subject, I have thought it proper to mention, as highly deserving notice and showing the propriety and advantage of operating at an early period of the complaint. It is unfortunately the case, that patients can seldom be convinced that there is any necessity for an operation while the disease continued in a mild state ; whereas, that is beyond all doubt, the most favourable period for extirpating it." Fearon regarded rapid healing as of great importance and mentions the fact that the disposition to unite in fresh incised wounds is very great, so that healing should be almost completed in about ten days. These ideas, put forward by a young man with only a few years experience, were naturally frowned upon by the older surgeons.

Hunter seems to have been the first to point out the hardness of malignant tumours as a characteristic sign in diagnosis. Harold Burrows in his chapter on malignant disease in the *History of some Common Diseases* published in 1934, states that " he also has priority, it appears, in drawing attention to the central necrosis which takes place in these growths." As in all his activities, Hunter brought to his study of this affliction which, he estimated, attacked about one person in a thousand, his scientific approach to " unnatural dispositions " in general, rejecting even long established methods of treatment if they did not conform to his theories of healing, and adopting bold measures when he was assured of their success.

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CEREMONY OF PRESENTATION OF DIPLOMAS

THE SECOND ANNUAL ceremony of the presentation of diplomas was held on the afternoon of 10th June 1959. The President and Council, preceded by the Mace, processed up the Edward Lumley Hall, which was filled with diplomates and their relatives, to the dais, accompanied by representatives of the Court of Patrons. Members of the Court of Examiners and the Boards of each of the Faculties were also present, all wearing their College robes.

The President (Professor Sir James Paterson Ross) opened the meeting with the following words :

" This is an Extraordinary Meeting of the Council of the College. It is held in order to admit certain Fellows and to present diplomas to the candidates who have been successful in examinations during the past year. Before we actually start the business of the Council, I would like to say just a word of welcome to all of you because it gives us very great pleasure in the College to be able to hold this ceremony, not only to admit new Fellows and other diplomates to the College, but also to give an opportunity to those of you who are relatives of the new Fellows and Members to visit this College and see something of the life of the College itself, so please understand that you are all extremely welcome here this afternoon."

The first item on the agenda was the admission to the Honorary Fellowship of Dr. Paul R. Hawley, who was escorted to the dais by the Vice-Presidents (Sir Archibald McIndoe and Mr. A. Dickson Wright).

The President welcoming Dr. Paul R. Hawley to the Honorary Fellowship, with the two Vice-Presidents escorting him.

Professor Digby Chamberlain then delivered the following citation in honour of Dr. Hawley.

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PRESENTATION OF DIPLOMAS

" Mr. President, Members of the Council, Ladies and Gentlemen : It would seem almost impossible for one man to have done so much and with such success as Paul Ramsey Hawley, who stands before you.

" A native of Indiana, he entered the Medical Corps of the U.S. Army as a career, and in the second world war he was in this town as Chief Surgeon to the American Forces in the British Isles. Later he became Chief Surgeon to the Forces in Europe. He was in the Army until 1946. During his time in England the size of his commitments can be seen when we know that he had under his command rather over a quarter of a million officers and men, and during that time he was responsible for the leasing or building of over 203,000 hospital beds.

" After he retired from the Army he was for eighteen months Chief Medical Director of the Veterans Administration, and he then became Chief Executive Officer of the Blue Cross and Blue Shield Organizations, a position which he held until March, 1950, when he became Director of the American College of Surgeons. In this present appointment he spends a good deal of his time on the move in his own country. He is a frequent visitor to this country and to those parts of the world to which the activities of his College call him.

" It would hardly seem that he has time for any other activities, but he was at one time a keen polo player, and he had a handicap of four at golf. He now spends his leisure time in his yacht, a cabin cruiser on Lake Michigan, which is equipped with everything that is latest in the way of electronic equipment to meet the hazards that can occur on that great inland sea. He is a keen photographer and is responsible for a certain number of the photographs which appear in the Bulletin of the American College of Surgeons, and in his apartment, I am told, he is an amateur cabinet-maker, much to the annoyance of his neighbours who don't appreciate the noise which goes with that particular activity.

" General Hawley's worth has been widely recognised. He is an Honorary Doctor of Laws of five universities, including the University of Birmingham in this country. He is a Doctor of Science of two universities : he is an Honorary Fellow of the American College of Surgeons, the American College of Physicians, the Royal College of Surgeons of Edinburgh and of the Royal College of Physicians here in London. He has been decorated by his own country, by Belgium, by France, by Nicaragua, by Norway, and in this country he is a Companion of the Order of the Bath.

"Those of you who know Paul Hawley will think of his devoted service to the American College of Surgeons, of his work for the improvement of the standards in hospitals in the United States, and of his campaign for the integrity of surgeons and of surgery wherever it may be. He has been described, aptly I think, as the ' moral conscience of medicine in the North American continent.'

" We like to think of him in all these ways but in addition we like to think of him as he has shown himself to be on numerous occasions, both in war and peace, a staunch friend of this country and of this College.

" Mr. President, I have the honour to present to you, to receive at your hands the Honorary Fellowship of this College, Paul Ramsey Hawley."

After the President had admitted him to the Honorary Fellowship, Dr. Hawley replied :

" Mr. President : I was a little embarrassed at the expressions of amused incredulity at the recital of my athletic achievements whereas everything else that my friend has said was accepted without comment.

" Mr. President, for many years now my obligations to this College have grown until today they have reached the point of insolvency. During the dark

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days of the war, one of your distinguished predecessors, the Lord Webb-Johnson, extended the hospitality of the College to me upon many occasions and the only sombre cloud in my horizon today is that he cannot be with us so that I might once again express the esteem in which I shall always hold the friendship which he bestowed on me.

" Standing here today I can see assembled on this platform the shadows of many illustrious men who have made notable contributions to the advancement of surgery. This is a sobering vision, Mr. President, which must raise within men much more distinguished than I the doubt of their worthiness to receive this honour, a doubt which urges them not to accept anything which they have not fully earned. But the great prestige of this College, built through centuries of leadership in surgery, has placed a value upon this distinction which is beyond the restraining influences of conscience ; and so, Mr. President, with this admission and with humility, it makes me very happy to join the ranks of those whom this College has honoured."

The next item on the agenda was the admission to the Fellowship of four distinguished medical practitioners of at least twenty years' standing— Dr. A. H. Bennett, Dr. S. F. Logan Dahne, Sir Henry Pierre and Professor A. J. E. Cave. After each had made the required declaration and had signed the book of the Bye-Laws, Dr. Bennett spoke on behalf of them all, saying :

" Mr. President, Members of Council, Ladies and Gentlemen : By what I feel is nothing but an alphabetical accident, it has become my lot to say ' thank-you ' for the honour which we have just received. We all know the Royal College of Surgeons as a very friendly College, right from the very beginning when we first qualify ; it receives us as Members, not like another College which just gives us a Licence, and that feeling of friendship is a very real one. To be a Member of a College is very different from having a Licence from it.

" The presence here this afternoon of Professor Cave reminds me of other pleasant instances in my association with the College. When I was a student I used to visit the College, partly with a wholesome desire for knowledge and partly so that I could learn to spot specimens which I should come across at future examinations. On these occasions there was a friendly familiar figure in a white coat with tousled white hair, who always took an interest in the students who came in and who always gave them kindly help. I mean Sir Arthur Keith, who was a predecessor of Professor Cave's.

" I am sure all of us have some similar happy memories of the College. When actually I came to qualify, my first examination was one in Pathology and Morbid Anatomy, and it was held in this building. It was a most inauspicious day, it was Friday, the 13th April, I remember, and on the way I passed a policeman's funeral. I arrived thinking all was lost, and then I came into the examination room and there on the desk in a bottle was a gall-bladder which had received various insults, more than one, from Nature, which I knew as an old friend. I knew the very legend that was on it and was masked by a piece of brown paper. I did not admit that, I played crafty : anyway, all was well and once more I had a happy association with the College.

" So, Sir, I can think of no better words than those in the Book of Common Prayer : ' We, Thine unworthy servants, do give Thee most humble and hearty thanks.' "

Then came the admission by election to the Fellowship of the Faculty of Anaesthetists of Dr. R. H. P. Fitzpatrick and Dr. G. A. Haydock, who

were presented to the President by the Dean of the Faculty, Dr. Geoffrey Organe.

The Council then received the list of those candidates who had been successful in the recent Final Examination for the Fellowship, and granted diplomas of Fellowship to them on the motion of Sir Reginald Watson-Jones, a member of both Council and Court of Examiners.

Members of the Council and others who were to present candidates for their diplomas then proceeded to leave their seats at the front of the Hall and move back to join the parties of diplomates from their own medical and dental schools. The diplomates then walked in procession up to the dais, the Members of Council and Court of Examiners presenting the Fellows and Members, and the Fellows and Licentiates in Dental Surgery and Fellows in the Faculty of Anaethetists being presented by members of the appropriate Board of Faculty.

At the request of the Council, Dr. Hawley then addressed the new diplomates :

" Some few years ago, a distinguished British surgeon visited my country and attended several surgical meetings during his stay. In a published account of his experience, he remarked upon the frequency with which problems of secondary, reparative surgery are discussed in the United States. One example, which impressed him, was the problem of injury of the common bile duct, an accident which he stated, with complete truth I am sure, to occur much less frequently in Great Britain.

" In casting about for a topic to discuss today, it occurred to me that it might prove of some interest to you to trace briefly the evolution of surgical practice in America, wherein is to be found the explanation of this difference in surgical experience.

" There are several factors which contribute to this difference ; but the principal ones, and the only two which time will permit me to mention, are that our system of licensing the practice of medicine and surgery does not provide for effective control of surgery, and few of our people are conditioned to specialization in medical care. Licensing of medical practice is a relatively recent development in the United States. While an attempt had been made to regulate the practice of medicine in the colonies—Massachusetts having made one in 1649—only a few States had a licensing system prior to 1880. My father, who was graduated in medicine in 1885, practised in the State of Indiana for almost fifteen years before a license was required ; and my grandfather for forty years.

" In the second place, even after licensing was introduced, the type of licence issued in the United States does not provide any control whatsoever of surgical practice. In Britain, licensing is a function of professional bodies dedicated to high standards of practice. In the United States, it is a function of government, but not of the Federal Government. Each State of the Union issues licences to practise within its own boundaries, and there is only one grade of licence. There is no country-wide licence ; there are forty-eight State licences, soon to be fifty, and a considerable variation in the difficulty of the examinations given to obtain them.

" In one respect, all State licences to practice are identical. They permit the unlimited practice of both medicine and surgery. I hold licences in two States—one by examination and the other through reciprocity. I am legally qualified to undertake any procedure in medical care in each of these two States—hypophysectomy, pneumonectomy, portacaval shunt and prescription of a dose of

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castor oil. The tragic thing is that, if I were to set up in the practice of surgery, I would have little difficulty in obtaining patients. My licence may not be revoked for undertaking something for which I am totally unqualified. The only restraining influences would be my conscience and the danger of a civil suit for malpractice.

" This is a problem which you do not have. While there may be no more legal restrictions here, other forces serve to limit the practice of surgery to those who are properly trained to undertake it. The sharp line dividing the surgeon from the physician was drawn here several centuries ago. To prevent any confusion of the two disciplines, you have even adopted different forms of address. In a recent novel, based upon the life of John Hunter—a book which must not be mentioned in Glasgow, as I learned last summer, because it is not very complimentary to his brother, William—there is a scene in which four physicians are gathered in a coffee shop in Covent Garden. One of them is disturbed over the growing pretensions of London surgeons ; and he expresses his indignation thus : ' The year 1745 marked the greatest blow ever to befall physic, gentlemen. When those rascally surgeons set themselves up as a separate group from the barbers, physic suffered the cruellest blow ever dealt. Mark me,' quoth he, ' they'll be calling themselves doctors next. Or petitioning the Crown to that effect. Not a man in the lot is good enough to shave my coachman.'

" This dire prediction of the good doctor has not materialized. Instead, British surgeons have elevated the title of ' Mister ' to a new dignity. Your insistence upon being addressed as Mister provides a perfect example of the conversion of a necessity into a virtue. It is worthy of the celebrated British genius for carving victory from defeat.

" The first medically trained people in the American colonies came from Britain. They arrived as specialists, either as physicians or surgeons, but their specialization ended the moment they set foot in America. There were too few of them to provide each community with both a physician and a surgeon, so physicians were forced to reduce fractures and treat wounds, and surgeons to prescribe for smallpox and dysenteries. Thus was distinction between medicine and surgery erased, and the pattern of unrestricted general practice established in America—a pattern of far wider scope than general practice in Britain, a pattern which does not exclude operative surgery.

" The first medical school in America, that which is now in the University of Pennsylvania, was established in 1765 ; and the second, the College of Physicians and Surgeons of Columbia University, in 1767. The Philadelphia school graduated its first class in 1768. There were twelve graduates, eleven Americans and one British citizen. Since the school owed its existence to the training its faculty had had in Britain, the trustees decided to recognise this obligation by awarding the first diploma to the Briton. The eleven Americans mutinied and served notice that they would not accept diplomas under such a condition ; whereupon the trustees relented and awarded the diplomas in alphabetical order. This was, perhaps, the first rebellion against the Mother Country, antedating by a few years the Boston Tea Party.

" Prior to the establishment of these schools, with the exception of the very few who could afford to go to Europe for training, all physicians and surgeons in America were trained by the apprentice system. Since the preceptors were all general practitioners, the apprentices followed the same pattern of practice, so that, by the turn of the XVIII Century, all distinction between physicians and surgeons had been lost in the American colonies. The joint appellation of ' physician and surgeon ' was conferred upon all graduates of medical schools and is so today.

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" As the boundaries of the Colonies were pushed westward, the same situation obtained on the frontiers as had existed in the first settlements. Populations were sparse and scattered, and medical men scarce. Thus the pattern followed the migrants across the Alleghany Mountains, and, for the next century, to the Pacific Coast.

" In the meantime on the Atlantic seaboard, villages were growing into towns and towns into cities. There grew up a number of cities of sufficient size to support specialization. Notwithstanding these areas of increasing density of population, specialization was not introduced into medical practice. I think that the most important reason is that there were no hospitals in the early Colonies. Of all medical disciplines, surgery is most dependent upon hospitals. It was primarily the hospital in Europe which elevated surgery from a skill to an art, and the surgeon from a barber to a professional man.

" The Pennsylvania Hospital was established in Philadelphia in 1754. It is still in operation and is the oldest hospital in the United States. The second hospital, the New York Hospital, also still in existence, was established in 1771. But by this time the American pattern of general practice had become too firmly established to be altered. How firmly this pattern was fixed by the year 1790 is indicated by the professional career of Philip Syng Physick, often called the Father of American Surgery. After taking some courses in the University of Pennsylvania, Physick came to London as the pupil, and later became the assistant, of your great John Hunter. He was Hunter's house surgeon at St. George's. With the possible exception of Edward Jenner, Physick was Hunter's favourite among all of his pupils ; and so highly did the master regard this American that he offered Physick a partnership in his surgical practice.

" Since Physick was a devoted admirer of John Hunter throughout his life, it must have been with great regret that he declined this unusual opportunity. That he regarded himself as a surgeon is indicated by the fact that he qualified for Membership in the Corporation of Surgeons in London, the progenitor of this College once removed. But he had determined upon returning to his native Philadelphia to practice ; and that he intended to conform to the pattern of practice in America is clearly indicated by the fact that Physick thought it essential to go to Edinburgh and take his degree of Doctor of Medicine before quitting Britain.

" Physick did practise in Philadelphia all of his life. Although his primary interest was surgery, and he occupied the Chair of Surgery in the University of Pennsylvania, he never restricted his practice to surgery. He enjoyed a wide reputation as a physician as well as a surgeon. Like all of his contemporaries, and those who followed him in the next hundred years, he was a general practitioner.

" The American Surgical Association is, and has been since its founding, the most exclusive surgical society in America. Founded in 1882, every charter member was a general practitioner. Strict limitation of practice was not to come for more than another quarter-century.

" Great Britain has exerted more influence upon American medicine than an other country. With few exceptions, our early medical leaders were trained in England and Scotland. That they did not bring back with them the British pattern of practice is because the social structure and economic situation in the Colonies were not favourable to specialization ; and, by the time specialization would have been possible, the early pattern had become too firmly established to be changed easily. Change was finally forced by the rapidly expanding field of medical knowledge, but this has been largely a voluntary change by individuals. There are yet no legal and few moral restrictions.

" How, then, is surgery controlled in the United States ? In university-

affiliated hospitals, it is controlled as it is in Britain. All members of surgical faculties are fully qualified surgeons, and hospital appointments are controlled by them.

" (Before I confuse you further, I must explain that I use the term 'qualified ' in its broad, dictionary meaning, and not in the restricted sense of ' licensed ' in which you apply it in the sphere of medical practice. Fifteen years ago, after having lived among you for some four years, I prided myself upon my fluency in the English language ; but the years have dulled my facility and I now find myself lapsing occasionally into my native tongue.)

" In other hospitals, control of surgery is exercised principally through the Hospital Accreditation Program. This program was established by the American College of Surgeons in 1917. It is a purely voluntary programme without force of law. Standards of hospital operation have been established, among which is adequate control of surgery. Hospitals. which apply for accreditation, are surveyed periodically ; and those which meet the standards are given accreditation.

" When this programme was inaugurated, only a small proportion of the hospitals of the United States could meet the minimum requirements for accreditation. Today, approximately seventy per cent. of our hospital beds, in hospitals of twenty-five beds and larger, are accredited. Hospitals of less than twenty-five beds are not eligible for accreditation, which means that only about one-half of the total hospjtal beds in the United States are in accredited hospitals.

" Where, then, does the untrained man do his surgery? For the most part, he does it in some of the thirty per cent. of larger hospitals, and in the hospitals of less than twenty-five beds that are not accredited. Many of these are proprietary hospitals—i.e., hospitals owned by individuals or corporations, and operated for profit. I would imply neither that all unaccredited hospitals are bad, nor that all accredited hospitals are perfect ; but there can be no question of the average standards of each group.

" The American College of Surgeons has recently made a further contribution to the elevation of standards of medical care, both in medicine and in surgery. Supported by a generous grant from the Kellogg Foundation for the past six years, it has developed a method of auditing the quality of medical care which can be applied by the medical staff of any hospital. This has been adopted with enthusiasm in those hospitals in which it has been tried, and more hospitals are coming into the program each year. In surgery, this audit is concerned with the indications for operation, the type of operation performed, and the quality of pre- and post-operative care.

" The reason for the difference in surgical experience between our two countries is not to be found in philosophy of medical care, in the training of surgical specialists, or in legal regulation of practice. Our philosophy of medical care is part of the culture we inherited from you ; our method of training of young surgeons is so similar that we can interchange residents ; and, other than a broad, general licence to engage in the healing arts, neither country imposes any legal restrictions upon the practice of surgery.

" The reason for this difference is that too few of our people are conditioned to specialization in medical care, and fully aware of the added training essential for qualification as a surgical specialist. Although science has freed medicine from the dogmas, the unsupportable hypotheses and the empiricisms which shackled it for centuries, and has made the burden of medical knowledge too heavy for one man to carry all of it, too many of our people still insist upon preserving the tradition of the omniscience and omnipotence of the family physician with his little black bag and his immense understanding of the psychology of patients. They retain unlimited confidence in a legal licence to

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practise medicine, regarding it as a guarantee of competence to undertake the gravest of surgical procedures.

" Nothing that I have said must be construed as any reflection upon the general practice of medicine. It is still, and will always remain, the only solid foundation for good medical care. But, just as no enduring superstructure can be erected without a foundation, no foundation can fulfil all of the functions of a building. Each has its own important function, and each has its own limitations.

" Your centuries of sharp distinction between medicine and surgery have conditioned your patients to the difference between the qualifications for these two fields of medical practice ; and the terms ' physician ' and ' surgeon ' do not appear upon the same office sign as they do so often in America. It is really the patient that is the ultimate factor in the control of surgery in Britain, and who, in America, is the greatest obstacle to the improvement of the average quality of surgical care. If I were to establish myself in surgical practice in your country and, by hook or crook, obtain surgical privileges, I would get no patients. But, were I to do this in America, I would have patients, and it would be injuries to their common ducts which would be discussed in our sur- gical meetings. This, in a nutshell, explains the difference between your surgical experience and ours.

" Rather than being discouraged with the bad surgery we have in America, I think it remarkable that we have so much good surgery. We have been denied the years and years of influence of your Royal Colleges in the control of surgical practice. We have only started to work by education and moral suasion— educating the public upon the qualifications to undertake surgery and influencing lay trustees of hospitals to restrict surgical privileges to qualified surgeons. Your pattern of medical care had been established before America was settled, and you have had only to build upon it as surgery advanced. Had the Royal Colleges emigrated with the colonists, we would have been spared three centuries of undirected effort.

" There is something else I should like to mention, which I think is creditable to American surgery. With the opportunities for unqualified men to build lucrative surgical practices, young men with easy consciences might well hesitate, after being fully licensed to do surgery, to spend four or five years of hard work on starvation incomes in order to qualify as a surgeon ; but young Americans are obtaining adequate training in rapidly increasing numbers. Many more apply each year for resident training than can be placed in our better pro- grams.

" The requirements for admission to Fellowship in the American College of Surgeons have been raised significantly in the past ten years. Notwithstanding the greater difficulty in obtaining Fellowship, our annual Convocation Classes have risen from between five and six hundred, ten years ago, to one thousand to twelve hundred today. This is a reflection of the increased voluntary demand for adequate training before engaging in the practice of surgery.

" Our real progress dates not much earlier than the turn of the Twentieth Century, and the greatest impetus of all has been given by the American College of Surgeons. For some twenty years after the founding of the American College of Surgeons, its Fellowship was the only formal recognition of qualification as a surgeon. Certifying Boards, also voluntary and without legal authority, were established in the 1930s. For some years, there were differences between the requirements of the Boards and those of the College. These have since been erased. About ninety per cent. of those now admitted to Fellowship in the American College of Surgeons have already been certified by a Board ; and the remaining ten per cent. have met the training requirements of the Boards and are eligible for examination. Today, where formal evidence of qualification for

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appointment to a surgical staff is required, the requirement invariably reads ' Fellowship in the American College of Surgeons or a Diploma of an American Board, or both.'

" While the training requirements of the specialty boards in surgery and those of the American College are identical, there is a difference between them in the effectiveness of the control of the quality of surgery. The Boards conduct only a qualifying examination, which may be taken upon completion of formal training and before entering active practice and thereafter have little or no interest in their diplomates. The College requires that applicants for Fellowship have demonstrated in active practice both ability to *do* good surgery, rather than mere ability to pass an examination, and moral and ethical fitness to assume responsibility for surgical patients. Furthermore, the College continues its interest in its Fellows, and monitors their professional and ethical conduct throughout their careers. Fellowship in the American College of Surgeons is now being accepted by the public as a guarantee of both ability and integrity. For this reason, it is discontinued by the College when the conduct of a Fellow makes it impossible to continue this assurance.

" The American College of Surgeons was modelled quite frankly upon the Royal College of Surgeons of England ; and your leaders of that day officiated at its birth. We trust that you are not too disappointed in your godchild. Much remains to be done, but there is another fifty years ahead in which to do it. In effect, if not by formal action, the American College of Surgeons has adopted the motto of Julius Caesar, the free translation of which is : ' Counting the past is nothing while anything remains to be done.'

" Five years ago, almost to the day, it was my privilege to stand upon this rostrum to express the appreciation of the American College of Surgeons for the hospitality extended by your College. In a few words, I also spoke of my indebtedness to Britain, and my admiration of her people and her institutions. I shall not repeat these remarks, but I do wish to add that no British institution has, within its field of activity, exerted a more profound influence for good upon the rest of the world than has this great College. We, in America, are proud of the model we chose."

The senior Vice-President (Sir Archibald McIndoe) thanked Dr. Hawley for his address, and concluded :

" Those of us who have listened to you with care, and I am sure we all have, will realise that Professor Digby Chamberlain's citation was true in every word. Here is a man of international standing, a great soldier, a great administrator, and he now is proven to us as a great orator. I feel sure that these younger men who have just received their diplomas and other qualifications, if they wish to find a model to which they might aspire in the years to come, might well choose the towering figure of Paul Hawley, friend of this College."

The President then drew the meeting to a close and the assembled company withdrew to partake of tea in the adjoining rooms.

THE COLLEGE OF GENERAL PRACTITIONERS AND LINCOLN'S INN FIELDS

A Speech made by

Dr. J. H. Hunt

on

14th May 1959

to the President and Council of the Royal College of Surgeons

MR. PRESIDENT,

This is a sad occasion for me, but I am grateful for the opportunity of explaining the situation to you and to your Council. When a possible liaison between our two Colleges was first suggested four years ago, in the summer of 1955, many of us had great hopes that one day they would exist side by side. Our anonymous donor, walking round Lincoln's Inn Fields with me later that year, said that he would like to build headquarters for us there ; he wrote to say that he would pay the ground rent, too, suggesting a 999 years' lease. The houses were then, as indeed they are now (those which are left of them), four storeys high—the size of the building we had in mind—and a sum of £160,000 was mentioned as its possible cost. With this generous offer in mind, the plan for our headquarters on the site of Nos. 47 and 48 Lincoln's Inn Fields seemed a reasonable undertaking and there seemed, at that time, to be a good chance of this project being successful. We should have been able to maintain ourselves there comparatively easily, with your kind suggestion that we might use the Great Hall, library and lecture theatres of the Royal College of Surgeons. We appreciated fully all the advantages we should gain by being near you. With the help of Sir Edward Maufe we began to plan ; and with our donor's permission a notice was published in the national press.

From that moment troubles began, and circumstances seemed to turn steadily against us. First, the chairmen of the London Society and of the Georgian Group objected to the demolition of the old houses on the site, and after considerable discussion a decision had to be made by the Minister of Housing and Local Government. Next, the London County Council and the Royal Fine Art Commission insisted on a building eight storeys high instead of four, to match the other new buildings on that side of the Square. To obtain planning permission we had to add No. 49 to our project, because a single tall, thin building eight storeys high, with two staircases (which would have been imperative) and a lift, could have been of little use to anyone else. Our building had, at a stroke, become twice as high and half as long again as we had originally intended ; and its cost had risen threefold. We received a solicitor's letter about possible damage to the amenities of the Old Curiosity Shop at the corner. The question of " Ancient Lights " of No. 50 arose, and also £18,000 compensation to the Imperial Cancer Research Fund. For reasons outside our control the price of our proposed new building had already reached

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more than half-a-million pounds. The cost of its maintenance, t o, would be trebled, so that we should have needed an income of £50,0)0 per annum to run it and work in it which, as you know, means a cap al sum of about a million pounds. At the same time the length of tenure ve were offered was only a 99 years' lease—half of that for which we had asked (199 years)—at the end of which our successors would lose the whole building.

About a year ago we were all, including our anonymous donor and legal and financial advisers, becoming increasingly uneasy about the finances of this project—understandably so, I think you will agree. We still based our hopes on the possibility of a successful appeal to raise a million pounds being launched with vision, enthusiasm and enterprise. If we could not afford, at first, to occupy the whole building, we planned to let some floors for a while. There seemed to be, then, a sporting chance that this appeal would be successful ; but the situation is different now—the Royal College of Surgeons is appealing for three million pounds, and the Imperial Cancer Research Fund for a further million, and we cannot help being unhappy over difficulties which might arise if we were to join in this conflict of appeals for the development of the south side of Lincoln's Inn Fields. I believe that the appeal of the Royal College of Surgeons has raised, in a year, about one quarter of the sum it is seeking. If you obtain your last million pounds easily, it may prove us to have been wrong ; but the Royal College of Physicians also is now building on a new site, the appeal for the Royal College of Obstetricians & Gynae-cologists is still in being, the Queen's Institute of District Nursing is asking for a quarter of a million pounds, and there are many other public appeals which have been launched recently, such as that for the Churchill College. Dr. Bishop Harman, at the Medical Society of London's dinner this spring, said that all the medical Royal Colleges were undertaking new building programmes, and that they were all now or would soon be " in the red " ; he could not understand why the College of General Practitioners wanted to be there too!

Of these nine troubles, the short lease with its insecurity of tenure was the penultimate difficulty which, as you know from our discussions, worried us considerably. Doubt concerning our appeal has been the last straw. Recently our Council has had several long and most serious debates about this whole matter. At a meeting two months ago one of its forty-five members suggested that we should drop the Lincoln's Inn Fields project altogether ; at that time he could not find a seconder, because we all hoped it might still be possible to come here. But all these difficulties made us wonder seriously whether we should not be wiser, in the long run, to buy a suitable existing freehold property else-where, with absolute security of tenure and no building troubles. Soon after that—about the middle of March—this matter came to a head when the sale of the Incorporated Accountants' Hall, on the Embankment, was

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brought to our notice. Our Chairman wrote at once to tell you about this. It was in excellent condition and would have done us well for a hundred years or more ; its freehold price was £175,000. There were, however, certain difficulties over its purchase, constitutional and otherwise, and our donor thought we could do better ; we had no time to call a general meeting of our College before a decision had to be made, and we turned down the offer. But this possibility convinced us all of the advantages, just now, of acquiring a freehold existing building in good repair, as compared with the difficulties, frustrations and mounting expenses of erecting a new one.

We are in no immediate hurry to move, for our donor has provided us temporarily with 41 Cadogan Gardens—a good house with eleven rooms, about the size of the one which the Royal College of Obstetricians & Gynaecologists has occupied for the last twenty seven years. For the first five years of our College's life we worked from one room above my consulting room in Sloane Street, from which all the early developments of our College took place. Compared with this one room, the eleven rooms of the house in Cadogan Gardens seem spacious. Later on we shall have to find somewhere larger, just as the Royal College of Obstetricians & Gynaecologists has done now ; but we think we should be sensible to stay where we are until our finances are sound, not only for acquiring a new building but also for its maintenance and for the work we wish to do in it.

The decision not to come to Lincoln's Inn Fields has been a considerable personal disappointment to our President, to many members of our Council and to me, just as it has been, I am sure, to many of you. I have a file of more than 200 letters about this project, and have spent many hundreds of hours upon it. Our architects have prepared no fewer than five sets of drawings. Four years ago Sir Harry Platt spent much time, and took a great deal of trouble, in furthering this idea. The late Lord Webb-Johnson was particularly interested in it, and I had many long talks with him about it, the last only a few days before his death. My position on the Council of both Colleges has been somewhat difficult ; but no one could have been more helpful than Sir Harry Platt or you, Sir, or your Council ; and we appreciate very much indeed the kindness and co-operation you have all shown us. I do want you to know that no single thing which you or your Council have done, or anyone else has done, has led directly to our taking this decision ; no one has tried to persuade us to go elsewhere. It has been the inexorable piling up of difficulties which we have been unable to surmount. We felt last week that, in fairness to you all, a firm decision on our part was needed now. To have permitted this enormous commitment to go forward further in the face of the many difficulties I have outlined to you would, we believe, have been both impracticable and uneconomic and, to say the least of it, unwise.

More than two thousand years ago Thucydides said, " It is men, not

walls, that make a city." Even if our College has to progress rather slowly with its building programme we shall try meanwhile, from our present headquarters, to maintain and perhaps even enhance the traditional high standard of family doctoring in this country. I do hope, Mr. President, that you will all agree that the course on which we have decided is the prudent one ; and I only trust that this decision, forced upon us by developments outside our control, will do nothing to impair the friendly relations between our two Colleges.

A HISTORY OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND

ON THE OCCASION of the Centenary of the College in 1900, Sir William MacCormac wrote a brief account of its origin and development, but he made no serious attempt to write a formal history. In view of the recent great increase in scientific research and post graduate teaching within the College, the Council in 1958 considered that the time was ripe for an authentic history to be written, and it is hoped that this will be published within a few months. The publisher is Mr. Anthony Blond, who is taking great personal interest in the matter.

There was plentiful material to be drawn upon for writing the history. Within the strong room of the College are kept many volumes in which are recorded the Minutes of the Council and of the Court of Assistants going back to the time of the beginning of the College ; in addition there are full records of all the subsidiary committees through which the affairs of the College have been and still are administered. It is fortunate that these records suffered no damage at the time of the catastrophic injury sustained by the buildings of the College in 1941.

One might think that Minutes of Council meetings might be rather dull reading. In truth, to anyone with a spark of imagination and the power of reading between the lines, they soon spring to life and make thrilling reading. When once the characters and temperaments of the historical personages are understood it is possible to anticipate what their action will be on particular occasions. Sometimes, indeed, one gets direct or indirect evidence of the strong feelings which swayed our antecedents. This is shown by the frequency with which resolutions passed at one meeting were not confirmed at the next ; by the fact that for several years the names of those who voted for and of those who voted against important motions were recorded in the Minutes ; and by the occasional recording in the minutes of feelings of displeasure or even motions of censure.

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The perusal of these records has brought to light many facts which have never previously been published and it is likely that this fresh information may cause certain received opinions to be reconsidered.

The narrative, which begins in 1745 and ends in 1957, is contained in thirty chapters, each of about ten pages. At the end are about one hundred thumb-nail biographies of those who have played a part in the development of the College. A chapter which should appeal to every Fellow of the College is that in which the gradual development of the higher surgical examination is described. It will come as a surprise to many that at one period candidates for a higher surgical diploma had each to appear on two separate occasions before the whole council of the College, before whom they underwent a searching examination ere they were recognised as accredited teachers of surgery. Sometimes they had even to give a lecture on a particular subject before the assembled Council.

There are special chapters dealing with the Medical Act of 1858, with the birth of the dental profession and the institution of the L.D.S., with the development of the Conjoint Examination, and with the fight for the admission of women to the examinations of the College. Mr. LeFanu has contributed an interesting chapter on the history of the College Library, and Miss Jessie Dobson has written a most readable account of the history of the Museum of the College, in which are included brief biographies of the Conservators.

The latter part of the book deals with the remarkable changes which have taken place during the lifetime of many who are still living; it includes the period of the two World Wars, of the partial destruction of the College and of its resurgence into a great surgical centre with greatly increased accommodation, finer and better laboratories for research, and with a professorial staff which has converted the College into a world-renowned centre of post-graduate teaching of the basic surgical sciences.

We hope that every Fellow will wish to read the record of the famous College to which he owes allegiance. The book will be well illustrated.

Z. C.

HOWARD GRAY MEMORIAL LIBRARY

DR. HOWARD GRAY, consultant surgeon to the Mayo Clinic, before his death at the early age of 54 had already made a distinguished contribution to American surgery and surgical education in peace and war. He was a most generous friend and host to the many British surgeons who visited the Mayo Clinic and was well known in London where he delivered a Moynihan Lecture at the Royal College of Surgeons in 1951.

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It was four summers ago that Howard Gray lost his life tragically whilst swimming in Lake Pepin. The many friends in this country who admired him made a collection so that a memorial should exist to his memory in the Royal College of Surgeons of England, and this takes the form of a library of reference of a non-medical nature on the first floor of the Nuffield College. The central object in the library is a Family Bible, a gift from Mrs. Gray, which rests on the old President's desk which probably was used for one hundred years for the inkstand and quill-pen of Presidents long ago. The Bible, known as the Brown Bible, was a special edition printed in 1859 in New York, and is a beautiful production.

In the book cases one finds many well-known books of reference, concordances and commentaries, so that this will form a valuable supplement to the comprehensive medical library of the College. Whether it be the composition of a medical paper, an after-dinner speech, the settlement of an argument or the solution of a crossword puzzle, the answer is there. It is fascinating to take a medical word and find how many times it is mentioned in the Bible, Shakespeare or Pepys' Diary, and then to study the context.

In addition to the Bible there are books and furniture provided by his British friends, a series of volumes on the histories of Greece and Rome, given by the librarian of the Mayo Clinic, a number of books given by Charles Mayo and articles of furniture from Dr. Gray's old colleagues in Rochester.

The walls are adorned by a picture of Howard Gray and a short dedicatory inscription ; and the company who gather round the Howard Gray family on the opening at 24th September at the opening will be those who loved and esteemed Howard Gray for his great gifts as a man and as a surgeon. Our minds will go back to his wonderful operative technique and courteous behaviour in the theatre. We will think of his lovely hospitable home and the happiness of his family and the religious background of their lives. The writer will remember most his ward rounds, where he dealt so kindly and wisely with his patients—just as I imagine Lord Lister must have done when the poet Henley penned these lines about him :

> " His face at once benignant, proud, and shy,
> His faultless patience, his unyielding will,
> Beautiful gentleness and splendid skill,
> Innumerable gratitudes reply.
> His wise rare smile was sweet with certainties
> And seemed in all his patients to compel
> Such love and faith as failure could not quell."

A. D. W.

An account of the opening ceremony of the Howard Gray Memorial Library will be published in a future issue of the *Annals*.

In Memoriam

BERNARD R. M. JOHNSON

F.R.C.S., F.F.A.R.C.S., F.F.A.R.A.C.S. (Hon.)

1905—1959

" *Whom the gods love die young* " : Bernard Johnson had only recently passed his fifty-fourth birthday when he was cut off by sudden death. His early years were spent at Brighton College and Middlesex Hospital, and he qualified in 1927. He would fain have been a surgeon, but circumstances entirely unconnected with examinations directed his enthusiasm and energies towards the field of anaesthesia. The kindly advice and the practical help of colleagues like Raymond Apperly and Harold Crampton he never forgot. For a time he was anaesthetist to St. Peters and to the dental department of University College Hospital, but by 1936 he attained the full rank of Honorary Anaesthetist to his own Middlesex Hospital.

The Second World War found him in West Africa, the Middle East, North-West Europe and the Central Mediterranean sphere of operations, in which last locale he was adviser in anaesthetics. In 1952 he was appointed civil consultant in anaesthesia to the War Office.

Bernard Johnson was the first vice-dean and the second dean of the recently constituted Faculty of Anaesthetists within the Royal College of Surgeons : he believed most passionately in the Faculty, and from the very first days of its creation he worked with all the ebullient enthusiasm of a Crusader, and not without a gratifying measure of success, to enlist the practical interest and sympathy of the pharmaceutical industry in the Faculty. He continued to prosecute his missionary duties with unabated zeal right up to the time of his death, and had the satisfaction of seeing a research department of anaesthesia established within the Faculty, and of realising that single-handed he had collected the very considerable sum required for the purpose.

He was immensely proud of his election to the Fellowship of the College towards the close of his term of office as dean of the Faculty, during which time he had a seat on the College Council. Perhaps this honour fanned his zeal and augmented his efforts for anything connected with Lincoln's Inn Fields.

I have written elsewhere that perhaps loyalty was his most distinctive trait—loyalty to his elders as well as his contemporaries in the fields of surgery, loyalty to his Faculty and his anaesthetist contemporaries and juniors, loyalty to the Royal College of Surgeons, and an unswerving devotion towards any task which he had undertaken.

He was a great teacher of anaesthesia, and by precept and in practice he was tireless in his efforts to bring modern anaesthesia to the continent

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of Europe. For him "anaesthesia has no frontiers," and his war experience had taught him the barren nature of the continent in the sphere of anaesthesia. It would be most insulting to his memory to refer to his great qualities as a practical anaesthetist, but I would like to stress his personal kindness to every patient, and nothing but the very best in the work of his pupils was ever tolerated, whatever the calibre of the surgical procedure.

To me he remained the same keen, enthusiastic kindly worker that he was thirty-two years ago, when he was my much loved house-surgeon.

G. G-T.

DONATIONS

THE FOLLOWING GENEROUS donations have recently been received by the College :

Appeal Fund:

£5,000	William Johnston Yapp Charitable Trust.
£2,500	Ford (Dagenham) Charitable Fund.
	Pearl Assurance Company, Ltd.
£1,450	Joseph Collier Charitable Trust (first of seven annual contributions).
£1,000	Reckitt & Colman Holdings Ltd.
	Alfred Holt & Company (P. H. Holt Trust) and £100 p.a. for five years starting June 1960.
£500	Timothy Whites & Taylors, Ltd.
	Winterbottom Book Cloth Company, Ltd.
	Prof. A. Stanton Whitfield $+$ £1,000 left in will.
	Bristol Siddeley Engines Ltd.
£400	J. Y. Sangster, Esq.
£262 10s. 0d.	Trustees of the late Miss E. Rathbone.
	McKechnie Brothers Charitable Trust.
£250	Albert Reckitt Charitable Trust.
	The Nestlé Company, Ltd.
	The Morgan Crucible Company, Ltd.
	Rubery Owen Group Charitable Trust.
£210	Textile Machinery Makers Ltd., Charitable Trust.
	Ore Sales & Services, Ltd.
£200	District Bank Ltd.
	Kodak Ltd.
	Northern Assurance Company, Ltd. (first of seven annual contributions).
	American Dental Society of London.
£105	Vitamins Ltd.
	Grayson Rollo & Clover Docks Ltd.

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£105	Anonymous donor.
	Allen West & Company, Ltd.
	Colgate-Palmolive Ltd.
	J. V. Drake & Company, Ltd.
	Sir Percy Lister.
	Higgs & Hill, Ltd.
	R. Hewitt, Esq.
£100	Union Corporation Ltd.
	Hogg, Robinson & Capel-Cure, Ltd.
	J. D. McKechnie, Esq.
	Engelhard Industries Ltd.
	Courage & Co. Ltd.
	Friends Provident & Century Life Office (first of seven annual contributions).
	Littlewood Charitable Trust.
	Alexander Discount Company.
	Bank of London & South America, Ltd.
	Provincial Insurance Company, Ltd.
	J. Malcolm Harrison, Esq.
£52 10s. 0d.	Warren-Swettenham Charitable Trust.
	Toledo Woodhead Springs Ltd.
	Ryders Discount Company Ltd.
	South Staffs. Wagon Company Ltd.
	Cotesworth & Powell Ltd.
	Haleybridge Investment Trust, Ltd.
	Gee, Walker & Slater, Ltd.
	S. Figgis & Company, Ltd.
	E. W. Vincent Trust Fund.
	Aladdin Industries Ltd.
	C. E. Kindersley, F.R.C.S.
£50	Charles Hill of Bristol, Ltd.
	The Delta Group.
	The Thermal Syndicate Ltd.
	Demolition & Construction Company.
	Hargreaves (Leeds) Ltd. (first of seven annual contributions).
	Prince of Wales Dry Dock (Swansea) Ltd.

Department of Dental Science:

£500	Cocoa, Chocolate & Confectionary Alliance (first of five annual contributions).

Appeal Covenants:

£1,000 p.a. for 7 years	Associated Electrical Industries Ltd.
	The Distillers Company Ltd.
	English Electric Company Ltd.
	Beecham Group Ltd.

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£500 p.a. for 7 years	The Goldsmiths' Company.
£500 p.a. for 7 years + tax	Allen & Hanburys Ltd.
£400 p.a. for 7 years + tax	Birmingham Small Arms Company Ltd.
£300 p.a. for 7 years	Vernons Industries Ltd.
£286 p.a. for 7 years	Burmah Oil Company Ltd.
£150 p.a. for 7 years	Eagle Star Insurance Company Ltd.
	Employers Liability Assurance Corporation Ltd. & Clerical, Medical & General Life Assurance Society.
	Thomas Firth & John Brown, Ltd.
£143 p.a. for 7 years	Arthur Guinness Son & Co., Ltd.
£105 p.a. for 7 years	United Molasses Company Ltd.
£105 p.a. for 7 years + tax	Chesebrough-Ponds Ltd.
£100 p.a. for 7 years	Central Mining Finance, Ltd.
	Liverpool Warehousing Company Ltd.
	Thames Board Mills, Ltd.
£100 p.a. for 7 years + tax	Thomas W. Ward Ltd.
	Tysons (Contractors) Ltd.
	Jack Barclay, Ltd.
£100 p.a. for 10 years + tax	Royal London Mutual Insurance Society Ltd.
£78 15s. 0d. p.a. for 7 years	Provident Life Association of London Ltd.
£50 p.a. for 10 years	John Holt Overseas Ltd.
£50 p.a. for 7 years + tax	Coty (England) Ltd.
£20 p.a. for 7 years	Readicut Wool Company Ltd.
£10 10s. 0d. p.a. for 7 years + tax	Johnsen, Jorgensen & Wettre Ltd.
£15 p.a. for 7 years	Hobart Manufacturing Company.
	Ely Brewery Company Ltd.
£10 p.a. for 7 years	Finsbury Distillery Company Ltd.
	Greene, King & Sons Ltd.
£7 7s. 0d. p.a. for 7 years + tax	Hart & Levy, Ltd.

Restoration Fund Covenant:

£200 p.a. for 7 years	Albright & Wilson Ltd.

The Mayor and Commonalty and Citizens of the City of London have generously undertaken a Covenant which will total £2,500 over 7 years.

GUILDFORD CATHEDRAL
DOCTORS' WINDOW

THIS WINDOW IS being provided in the new cathedral at Guildford, which is nearing completion. Its two panes contain stained glass depicting St. Luke and Moses raising the serpent of brass.

So far £944 towards the total cost of £1,400 has been received.

The Treasurer of the Appeal, Dr. F. A. Belam of 1, Westfield, Epsom Road, Guildford, Surrey, would be glad to receive donations. Cheques should be made payable to " The Doctors' Cathedral Window Fund."

PAST PRESIDENTS (7)
SIR WILLIAM LAWRENCE, Bart.
by
W. R. LeFanu, M.A.
Librarian of the College
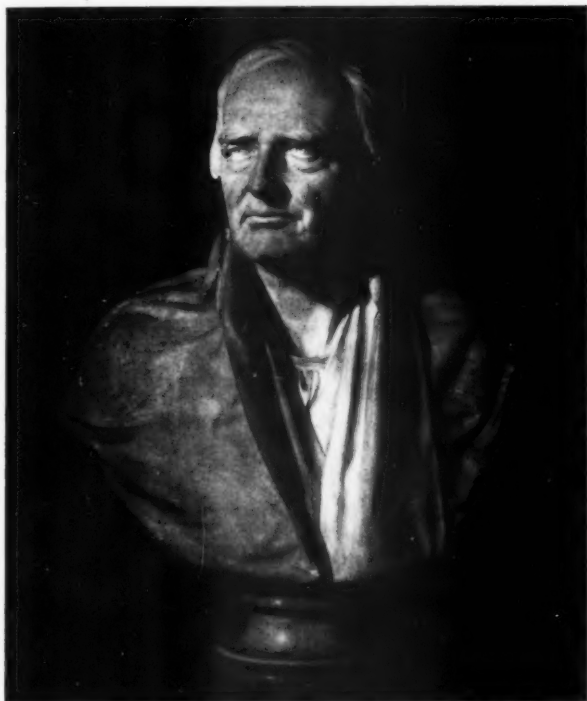
Sir William Lawrence, Bart.

SIR WILLIAM LAWRENCE, distinguished as surgeon, anatomist, and ophthalmologist, was a member of the Council of the College for forty-two years and was President in 1846 and 1855. With St. Bartholomew's Hospital he was connected for sixty-five years as student, teacher and surgeon. His Hunterian lectures of 1816-19 anticipated Darwin in discussing the evolution of life and the descent of man, but he bowed before the storm of orthodox prejudice which his views provoked. He took a prominent part in the protests of younger surgeons against the life-tenure and monopolist régime of the old Council of the College, but after his own election to it in 1825 he became a staunch and unyielding upholder of its privileges.

William Lawrence was born at Cirencester in 1783, the son of a surgeon, and was apprenticed in 1799 to the famous John Abernethy,

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surgeon to St. Bartholomew's Hospital, who became P.R.C.S. in 182 .
From 1801 to 1813 Lawrence was Abernethy's demonstrator of anatomy ;
although Abernethy's Presbyterian orthodoxy was outraged by Lawrence's
" advanced " views, Lawrence always expressed the warmest admiration
for his master.

Lawrence was admitted M.R.C.S. in 1805 and won the Jacksonian
Prize the following year for an essay on " Hernia and the best mode of
treatment." The *Treatise on Hernia*, which he based on this work, went
through five editions in thirty years. At the age of thirty he was elected
a Fellow of the Royal Society and was appointed assistant surgeon at
St. Bartholomew's the same year, 1813, becoming surgeon in 1824. He
became surgeon to the London Infirmary for the Eyes in 1814, and in
later years lectured and wrote on diseases of the eye ; his work on this
subject was translated into French and even into Arabic. He was also
surgeon to the Royal Bridewell and Bethlehem Hospitals.

At the College he was a Hunterian professor 1816-19 and Hunterian
Orator twice, in 1834 and 1846. He was elected to the Court of Examiners
in 1840, and in 1843 he was, with his colleagues on the Council, among the
first 300 nominated Fellows, when the Fellowship was inaugurated.

Lawrence was a man of fine physique and distinguished appearance.
The Council ordered a marble bust to be carved by Henry Weekes R.A.
immediately after Lawrence's death, and this is here reproduced. A few
years ago the College took the opportunity of buying two crayon drawings
of Lawrence by John Linnell R.A. and more recently the late Charles
Noon, F.R.C.S., of Norwich, bequeathed an oil-painting of him by
Charles Turner, A.R.A., painted about 1839. St. Bartholomew's Hospital
owns a portrait of him by H. R. Pickersgill.

Lawrence was appointed Serjeant Surgeon to Queen Victoria in 1858,
and Her Majesty created him a Baronet in 1867 when he was 84. That
summer he suffered a severe cerebral haemorrhage when mounting the
staircase of the College, and he died shortly afterwards at his home on
5th July, 1867. The College Library preserves several manuscripts in his
hand, chiefly case histories and notes for his lectures. He had the
reputation of being an outstandingly successful clinical teacher, lecturer
and orator.

Lawrence offended orthodox susceptibilities in his Hunterian Lectures
by assuming that the palaeontological evidence for evolution was accepted
by men of science. He directly denied the " divine inspiration of the
Hebrew scriptures," saying that the Book of Genesis could not " settle
the question " of the origin of the varieties of the human species. When he
implicitly denied the existence of soul, maintaining that " life " is a
function of the material organism, he was accused of " loosening the
restraints of society." He was attacked in a number of pamphlets, and the
" morality " of his views was discussed in the Chancery Court. Yet these
Hunterian lectures marked a real advance in discussing the " propagation
of natural variation," and laid the foundations of scientific anthropology.

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PROCEEDINGS OF THE COUNCIL IN JULY

PROFESSOR SIR JAMES PATERSON ROSS was re-elected President at a meeting of the Council held on 9th July 1959. Mr. A. Dickson Wright was re-elected and Sir Standford Cade was elected Vice-President.

Mr. R. V. Cooke of Bristol and Mr. H. Osmond-Clarke of the London Hospital were admitted as Members of the Council.

Dr. Cluny Macpherson of St. John's, Newfoundland, was admitted to the Fellowship, having been elected as a Member of twenty years' standing.

The Hallett Prize was awarded to J. K. Chaudhry, of the University of Lucknow.

Professors and Lecturers for the ensuing year were appointed as follows :—

HUNTERIAN PROFESSORSHIPS

(Lectures on Comparative Anatomy and other subjects, illustrated by preparations from the Hunterian Collection and other contents of the Museum, by Fellows and Members of the College.)

N. C. TANNER.—One lecture on the technique and late results of Porto-Azygos disconnection for oesophageal varices.

S. O. AYLETT, O.B.E.—One lecture on diffuse ulcerative colitis and its treatment by ileorectal anastomosis.

H. W. BURGE, M.B.E.—One lecture on vagal nerve section in chronic duodenal ulceration.

H. EDDY.—One lecture on cancer of the mouth.

R. G. ROBINSON.—One lecture on hydatid disease affecting the nervous system.

H. H. NIXON.—One lecture on an experimental study of propulsion in isolated loops of intestine, and application of the findings in the surgery of neonatal intestinal obstruction.

J. C. WATTS.—One lecture on missile injuries in Cyprus.

P. K. DURAISWAMI.—One lecture on experimental causation of congenital defects.

A. H. C. RATLIFF.—One lecture on fractures of the neck of the femur in children.

J. D. GRIFFITHS.—One lecture on the dissemination of cancer cells during operative procedures.

W. J. METCALFE.—One lecture on arterial embolism in the lower limbs.

K. BLOOR.—One lecture on the natural history of arteriosclerosis of the lower extremity.

R. L. HUCKSTEP.—One lecture on recent advances in the surgery of typhoid fever.

J. H. HOVELL.—One lecture on the surgical treatment of mandibular prognathism with special reference to functional anatomical considerations in diagnosis and treatment planning.

A. E. JONES.—One lecture on supervoltage X-ray therapy of intracranial tumours.

ARRIS AND GALE LECTURESHIPS

(Lectures on subjects relating to Human Anatomy and Physiology.)

N. R. BARRETT.—One lecture on some anatomical and pathological considerations concerning multiple hydatid cysts in the chest.

J. H. PEACOCK.—One lecture on endocrine and metabolic aspects of peripheral blood flow and vasospastic disease.

R. M. H. McMINN.—One lecture on the cellular anatomy of experimental wound healing.

JOSEPH HENRY LECTURESHIP

(Lecture on Occupational Surgery or Surgery in relation to occupation.)

L. GILLIS.—One lecture on arm prostheses and appliances. Their functional value in Industry.

ERASMUS WILSON DEMONSTRATORSHIPS

(Demonstrations of the pathological contents of the Museum by the Pathological Curator or some other duly qualified person or persons.)

J. B. ENTICKNAP.—One Demonstration.
L. W. PROGER,—One Demonstration.
H. G. H. RICHARDS.—One Demonstration.
M. O. SKELTON.—One Demonstration.
A. G. STANSFELD.—One Demonstration.
J. R. B. WILLIAMS.—One Demonstration.

ARNOTT DEMONSTRATORSHIPS

(Demonstrations of the contents of the Museum by the Conservator of the Museum or some other duly qualified person or persons.)

J. DOBSON.—One Demonstration.
A. A. BARTON.—One Demonstration.
S. ENGEL.—One Demonstration.
D. H. TOMPSETT.—One Demonstration.
B. D. WYKE.—One Demonstration.
D. G. WALKER.—One Demonstration.

Professor F. E. Lawton of Liverpool was admitted to the Board of Examiners in Dental Surgery.

The Begley Prize was presented to Dr. G. S. Makin of Liverpool University.

2 Diplomas of Fellowship, 2 Diplomas of Membership and 41 Licences in Dental Surgery were granted.

The following hospitals were recognised under paragraph 23 of the Fellowship Regulations :

HOSPITALS	POSTS RECOGNISED		
	General (6 mths. unless otherwise stated)	Casualty (all 6 mths.)	Unspecified (all 6 mths.)
SHREWSBURY—Royal Salop Infirmary (additional)		2 H.O.'s	
YORK—City and County Hospitals (additional)		3rd Cas. Off.	
EASTBOURNE — Princess Alice Memorial Hospital (additional)	R.S.O.		

AT A MEETING of the Council on 30th July, with Professor Sir James Paterson Ross, President, in the Chair, Mr. R. H. Franklin and Mr. Clifford Jones were re-elected and Professor R. S. Pilcher was elected to the Court of Examiners for a period of three years.

Professor M. A. Rushton was co-opted as a Member of Council to represent Dental Surgery.

Mr. B. W. Fickling was admitted as a Member of the Board of Examiners for the Fellowship in Dental Surgery and Mr. Leon Gillis, Mr. J. H. Peacock, and Professor A. S. Prophet as Members of the Board of Examiners in Dental Surgery.

The Hallett Prize was presented to Dr. J. K. Chaudhry of the University of Lucknow.

The Handcock Prize was awarded to E. W. L. Fletcher of St. Thomas's Hospital Medical School.

133 Diplomas of Membership were granted.

The following diplomas were granted, jointly with the Royal College of Physicians, in accordance with the appropriate reports : *Anaesthetics* (101) ; *Laryngology and Otology* (13) ; *Industrial Health* (16) ; *Pathology* (5) ; *Psychological Medicine* (51) ; *Public Health* (19) ; *Child Health* (1) ; *Tropical Medicine and Hygiene* (2).

Fifteen diplomas of Fellowship in Dental Surgery and one Licence in Dental Surgery were granted.

The following hospitals were recognized under paragraph 23 of the Fellowship Regulations :

HOSPITALS	POSTS RECOGNISED		
	General (6 mnths. unless otherwise stated)	Casualty (all 6 mths.)	Unspecified (all 6 mnths.)
LONDON—St. Charles' Hospital (additional)		2 Cas. Offs. (S.H.O.)	Regr. (Orth. and plastic) S.H.O. (Orth. and plastic)
DERBY — Derbyshire Royal Infirmary (additional)			S.H.O. (Orth.)
SIDCUP—Queen Mary's Hospital (redesignation)		*Redesignation of* S.H.O. (Cas. and Orth.) *as* Cas. Off. (Regr.)	
GRIMSBY — Grimsby & District Hospitals (redesignation)			*Redesignation of* Regr. (Gen. Surg.) *as* Regr. (Gen. Surg. & Orth.)
LONDON—Queen Mary's Hospital for the East End (additional)		2nd Cas. Off. (S.H.O.)	
LONDON—St. Andrew's Hospital, Bow (redesignation)		*Redesignation of* Cas. Off. (S.H.O.) *as* Cas. Off. (Regr.)	
LONDON—St. Olave's Hospital	*Confirmation of temporary recognition* S.H.O.		
MANSFIELD—Mansfield & District General Hospital (additional)	H.S.		

BOOKS ADDED TO THE LIBRARY

April—June 1959

Anaesthesia
> BOVET (editor). Curare and curare-like agents.
> GREENE. Physiology of spinal anaesthesia. Gift of Prof. R. F. Woolmer.
> PRYOR. Manual of anaesthetic techniques. 2nd edition.

Anatomy
> LOCKHART. Anatomy of the human body.

Bacteriology
> DUBOS. Bacterial and mycotic infections. 3rd edition.
> RIVERS. Viral and Rickettsial infections. 3rd edition. Both presented by the National Foundation, New York.
> MACDONALD. The motile non-sporulating anaerobic rods of the oral cavity 1953. Gift of Sir Wilfred Fish.

Biochemistry
> CARTER and others. Biochemistry in relation to medicine. 3rd edition.
> COLOWICK. Methods in enzymology, vol. 4.
> DIXON AND WEBB. Enzymes.
> HAUROWITZ. Progress in biochemistry since 1949.

Cancer
> BELISARIO. Cancer of the skin.
> CIBA. Symposium on carcinogenesis.
> JAFFE. Tumors and tumorous conditions of bones and joints.
> PACK AND ARIEL. Treatment of cancer. 2nd edition, vols. 1-3. Gift of the editor Dr. G. T. Pack, through the President.
> RUSSELL AND RUBINSTEIN. Pathology of tumours of the nervous system.
> UNIVERSITY COLLEGE HOSPITAL. Collected statistics of malignant disease 1946-50 (1958). Editor's gift.

Cytology
> BRACHET AND MIRSKY. The cell, vol. 1.
> BUTLER. Inside the living cell.

Laboratory Methods
> DONALDSON. Electronic apparatus in biological research.
> EDWARDS. Medical museum technology.

Neurology
> RANSON. Anatomy of the nervous system. 10th edition.
> SHY. External collimation diagnosis of intracranial neoplasia.
> WECHSLER. Textbook of clinical neurology. 8th edition.

Orthopaedics
> MERCER. Orthopaedic surgery. 5th edition.

Oto-rhino-laryngology
> ANSON AND BAST. The ear and temporal bone, 1955. Gift of the President, through Prof. Causey.
> DEGELS. Technique du traitement chirurgical de l'ozène. Author's gift.

Pathology
> MORRISON. The effect of advancing age on the human spinal cord.
> COLLINS. Modern trends in pathology.

Physiology
> KARPOVICH. Physiology of muscular activity. 5th edition.

Professional practice
> HADFIELD. Law and ethics for doctors.

Radio-physics, etc.
> BRAESTRUP AND WYCKOFF. Radiation protection.
> BRITTON. Hydrogen ions, vol. 2. 4th edition.
> BRYANT. Radioactive and natural strontium in human bone.
> ENGSTROM AND OTHERS. Bone and radiostrontium.

Surgery
> COPE. Early diagnosis of the acute abdomen : German, Italian, and Spanish (4th edition) translations. Gift of the author, Sir Zachary Cope.

HUGHES. Surgery of the colon.
MOSELEY (editor). Textbook of surgery, 3rd edition. A copy signed by the contributors and presented by the editor, Dr. H. F. Moseley, F.R.C.S., of Montreal, through the President.
OGILVIE. Hernia. Gift of the author, Sir Heneage Ogilvie.
POWER. Surgical technique. 2nd edition. Gift of the publishers, Messrs W. Heinemann.
WILDEGANS. Krankheiten und Verletzungen des Dickdarms und Mastdarms. Gift of Sir Henry Souttar.
WOMACK. On burns. 1953.

Tuberculosis

CAMERON AND LONG. Tuberculosis, medical research 1904-1955 (1959). Gift of the American National Tuberculosis Association.
HEAF (editor). Symposium on tuberculosis.

Urology

CHAPMAN. Urology in outline. Gift of Sir Eric Riches.

HISTORICAL COLLECTION

Historic Texts

GEMINUS. Compendiosa totius Anatomie delineatio 1553.
The very rare English translation; the College already possesses the first edition (1545) in Latin. Acquired through the good offices of Sir Hugh Lett. It is fully described by Sir Geoffrey Keynes elsewhere in this issue of the *Annals*.
HARVEY. De motu locali animalium, edited and translated by Gweneth Whitteridge, archivist to St. Bartholomew's Hospital.
The first edition of Harvey's manuscript preserved in the British Museum.
WILLIAM HUNTER. The gravid uterus, five plates reproduced from his atlas of 1774, with other anatomical plates. 1796.
GERBER. Atlas der Krankheiten der Nase. 1901.
HARTMANN. Atlas der Anatomie der Stirnhöhle. 1900. Both presented by Sir Victor Negus.

Biography

DICTIONARY OF NATIONAL BIOGRAPHY 1941-50 (1959) ; continuation of series.
CORNER. Anatomist at large.
MATHER. Two great Scotsmen—William and John Hunter. 1893. A copy containing autograph letters of the author and other memorabilia, presented by Dr. Douglas Guthrie.
OGILVIE. No miracles among friends. Gift of the author, Sir Heneage Ogilvie.
WIGGERS. Reminiscences and adventures in circulation research.

History of Medicine

BISHOP. A history of surgical dressings. Gift of the publishers, Messrs. Robinson, surgical dressing manufacturers.
EISELEY. Darwin's century.
HUGHES. A history of cytology.
MOODY AND BECKETT. Queen's Belfast 1845-1949. 2 vols. (1959). Gift of the Librarian.
PYKE-LEES. Centenary of the General Medical Council : history and present work.
RICHARDSON. The surgeon's tale. Revised edition. Author's gift.
SIMPSON. Shakespeare and medicine. Gift of the author, Mr. R. R. Simpson, F.R.C.S.
CREW. The Army Medical Service : Campaigns, vol. 3 (Medical history of the Second World War) ; continuation of series.
STOUT. War surgery and medicine, vol. 3 (official history of New Zealand in the Second World War) ; continuation of series.

HOWARD GRAY MEMORIAL LIBRARY
Presented through Mr. Dickson Wright
Second list of gifts

Benham. Book of quotations. 1948.
Fowler. Modern English usage. 1937.
Roget's Thesaurus of English words and phrases. 1936.
Webster's Dictionary of synonyms. 1951.

BOOKS ADDED TO THE LIBRARY

Brewer's Dictionary of phrase and fable. 1952.
Brewer's Reader's Handbook. 1898.
Nouveau Larousse universel. 2 vols. 1957.
Partridge. Dictionary of slang. 4th edition. 1951.
Hyamson. Dictionary of universal biography. 1951.
Barnhart. New Century encyclopaedia of names. 3 vols. 1954.
Webster's Biographical dictionary. 1957.
Low and Pulling. Dictionary of English history. 1904.
Hart. Oxford companion to American literature. 3rd edition. 1956.
Bryan's Dictionary of Painters. 4th edition. 6 vols. 1903–05.
Hastings. Dictionary of the Bible. 5 vols. 1947–58.
Hastings. Encyclopaedia of religion. 12 vols. 1940–55.
Pepys. Diary, edited by Wheatley. 9 vols. in 3. 1952.
Boswell. Life of Johnson, edited by Powell. 6 vols in 5. 1934.
Lindsay. A Burns encyclopaedia. 1959.
Gibbon. Decline and fall of the Roman Empire, edited by J. B. Bury. 7 vols. 1923–31.
Oxford History of England 1937—. 8 vols, to be completed in 14.
New Cambridge Modern History 1957—. 3 vols, to be completed in 14.

Presented by the Mayo Clinic Library

Clapesattle. The doctors Mayo. 1941.
Duruy. History of Greece. 4 vols in 8. 1889.
Duruy. History of Rome. 8 vols in 16. 1883–86.

Transferred from the College Library

Cambridge History of English Literature, vols 1-6 only. Gift of Mr. W. R. Gibson, F.R.C.S.
Chambers English Dictionary.
Harvey. Oxford Companion to Classical Literature. 1937.
Harbottle and Dalbiac. Dictionary of Italian quotations. 1909.
Haydn's Dictionary of Dates. 1898.
Middlemore. Proverbs, sayings, and comparisons. 1889.

DIARY FOR OCTOBER

Wed.	7	5.00	Prof. R. G. Robinson—Hunterian Lecture—Hydatid disease affecting the nervous system.*
Thur.	8	2.00	Quarterly Council.
		5.00	Mr. L. E. C. Norbury—Gordon-Watson Lecture—Gordon-Watson and St. Mark's.*
Mon.	12		Anaesthetic Course begins.
Wed.	14		Final L.D.S. Examination (Part I) begins.
			D.M.R.D. Examination (Part I) begins.
			D.M.R.T. Examination (Part I) begins.
		5.00	Board of Faculty of Anaesthetists.
Fri.	16		Course in Clinical Surgery and Surgical Lectures and Clinical Conferences end.
Tues.	20		Final Fellowship Examination (Ophthalmology and Otolaryngology) begins.
Wed.	21		Final L.D.S. Examination (Part II) begins.
			D.M.R.D. Examination (Part II) begins.
Thur.	22	4.15	Dr. S. Engel—Arnott Demonstration—The evolution of the mammalian lung.*
Fri.	23		Anaesthetic Course ends.
Mon.	26		Dental Lectures and Clinical Conferences begin.
Tues.	27	5.00	Dr. K. M. Backhouse—Arris and Gale Lecture—The gubernaculum testis hunterli—testicular descent and maldescent.*
Wed.	28		Primary F.R.C.S. Examination begins.
			D.M.R.T. Examination (Part II) begins.
		5.00	Mr. D. Greer Walker—Arnott Demonstration—John Hunter—Order out of variety.*
Thur.	29		D.Path. Examination begins.
		5.00	Mr. H. R. Thompson—Thomas Vicary Lecture—Sarjent surgeons to the Majesties.*

* Not part of courses.

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GAUDEAMUS IGITUR

Francis Bacon said : *"As men seek to receive countenance and profit from their professions so ought they to endeavour to be a help and ornament thereto."*

John Menzies Campbell has been this indeed. Scholar and historian, he has innate feeling for the past. Erudition, a dry wit and a common-sense which is anything but common, influence his writings, which have contributed much to our appreciation of our fathers that begat us. Universities and learned bodies, notably the University of Toronto, which wished to confer on him a Doctorate of Law, and dental historical societies in Europe and America have recognized his merits. The inception of an eponymous lecture in this College testifies to our measure of his worth : that he is the first dental surgeon to be elected to the Honorary Fellowship of our College is indicative of our high regard.

Edmund Burke said that great men are both landmarks and guide-posts. It is but fitting that on so historical an occasion we should remember our indebtedness to those who have gone before.

In the sixteenth century the University of Paris agreed to admit dental students and after 1699 those who wished to become dentists in France were required to take an examination : they were not allowed to use the description " expert on teeth " unless they had attended the College of Surgery : they had to practise for two years with a licensed surgeon and take theoretical and practical examinations.

In the preface of his great work *Le Chirurgien Dentiste*, Fauchard said that he offered his experience in the hope that it would be of use to those wishing to exercise his profession. His willingness to impart his knowledge was in striking contrast to the attitude of others and has been rightly regarded as a milestone in the progress of Dental Surgery. France led the way in dental education, but with the Revolution all tests for entry to the profession were abolished and Dental Surgery went into eclipse in that country for some years.

The medieval hospitals were refuges for the destitute and homeless sick : special provision was made only for leprosy and lunacy. Like other monastic institutions, they were swept away by the Reformation and only a few hospitals like those of St. Bartholomew and St. Thomas remained. Under Elizabeth, the care of the sick became the duty of the Parish, but in the eighteenth century the population began to rise steeply : leprosy, the Black Death and cholera had gone, poverty and ignorance remained. The Manor, the Monastery and the Guild had served their turn : something

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new was needed for an urban, industrial nation, and from 1700 till 1325
no less than one hundred and fifty-six new hospitals and dispensaries
were founded in Britain.

For a hundred years after Waterloo, with the exception of the brief
Crimean War, we were at peace and there was increasing prosperity.
The American and French Revolutions brought about a new sense of
responsibility for what were termed " the lower orders." This and the
Evangelical Movement encouraged humanitarian sentiments and practice.
Men like Robert Owen, Cobbett, Dickens, Shaftesbury, Carlyle and
Disraeli demanded better treatment for the under-privileged. The Society
for Superseding the Necessity for Climbing Boys was founded in 1803. It
offered a prize of £200 for the best sweeping machine which would obviate
the need to send children up the chimneys. Everywhere soup, coals and
tracts were being distributed, night schools and Sunday schools established
and shelters provided. The social conscience was aroused and the poor
had to be rescued from the gin parlours in which they had bought a brief
respite from their misery. Indeed Halevy, the French historian, thought
that it was the Evangelical Movement which saved this country from
revolution, bloodshed and violence. The eighteenth century saw the
institution of general hospitals : the nineteenth century the development
of specialized hospitals. Many were established in the first half of the
century and in the ten years 1860-1870 alone some thirty more were
founded.

Although John Hunter never actually practised dentistry, he was, after
his return from military service, according to Foot, closely associated
with James Spence at whose house he attended to advise patients. Hunter's
implants in cocks' combs, which are to be seen in the College museum,
were to demonstrate that transplanted teeth would survive (Fig. 1). His
Natural History of the Human Teeth, written in 1771 to pay the expenses of
his wedding to Miss Home, was his first work. There are many dental
specimens in the Hunterian Collection which are described in the manu-
script catalogues, one of which is in Hunter's own handwriting. Seven
years later, Hunter published his *Practical treatise on the diseases of the
teeth*. It has been truly said that Hunter unlocked the door and those
that came after passed through it.

The Minutes of the Corporation of Surgeons of Edinburgh for August
1772, show that James Rae, who had been Deacon, had regularly given
lectures in Dental Surgery " to rescue that department from ignorance and
unskilful hands." His son William came to London, where he attended
Hunter's lectures and in 1785 gave a course of lectures in dentistry himself.
In 1799 Joseph Fox, who had also attended Hunter's lectures, was
appointed Dental Surgeon to Guy's Hospital, where he gave the first
systematic course in Dental Surgery at a medical school in the spring of

that year. The British Dental Association has the manuscript copies of his lectures which were published in 1803.

Fig. 1. Implant of tooth in cock's comb by John Hunter (from museum of Royal College of Surgeons of England).

Those wishing to become Dental Surgeons became pupils of established practitioners. In 1820 L. S. Parmly offered instruction in the art of dentistry to gentlemen of education. His fee was from one to two hundred guineas : some pupils paid fees of as much as five hundred guineas. Later boys were indentured for from five to seven years : they often served with a jeweller for a term. They were bound not to divulge their master's secrets, and not permitted to marry, to play cards, dice, or to frequent taverns or play-houses. They learnt to carve dentures in bone and ivory and practised extractions on the poor patients who sought free treatment from their masters, usually between 9 and 10 every morning. Describing his own pupillage seventy years ago, J. H. Badcock said that no general anaesthetic was given but the gums were sprayed with ether or chloroform paint applied. Sterilization of instruments was never thought of. In the interval between patients, the dental surgeon would instruct his

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pupils. At the beginning of the twentieth century, an apprentice received
the weekly wage of half-a-crown in the first year, rising to as much as
ten shillings in the fifth. If he did not intend to qualify, he became an
improver with a wage rarely exceeding twenty-five shillings.

Horace Hayden was licensed to practise dentistry in Baltimore in 1810.
About 1825 he was asked to lecture on dental surgery to medical students
at the University of Maryland and conceived the idea of opening a Dental
School. Queen Victoria had been on the throne for three years when the
Baltimore College of Dentistry, the first Dental School, opened on
1st February 1840. The teaching staff were Hayden, Chapin Harris and
two physicians. Five years later the Ohio Dental College opened in
Cincinnati.

George Waite's father was dentist to George IV. George was educated
at Eton and studied in Paris under Dupuytren. He passed the examination
for the Membership of this College in 1824 but had to wait a year before
he was twenty-one and could receive the Diploma. His Appeal to Parlia-
ment, the Medical Profession and the Public on the present state of Dental
Surgery, issued in 1841, began the movement that culminated in the event
we are commemorating today. Two years later John Tomes and seventeen
others petitioned the College to institute an examination in Dental Surgery
without success. It was these men who founded the Odontological
Society. In August, 1855, a letter from Samuel Lee Rymer appeared in the
Lancet : this urged the necessity for a College of Dental Surgery and a
Board of Examiners who could grant a licence. Two factions formed : a
small but influential group who wished Dental Surgery to develop under the
aegis of the College and a much larger body of practitioners who wished
to be independent. Tomes, who was Dental Surgeon to the Middlesex
Hospital, enlisted the help of James Arnott, a surgeon on the staff of the
Middlesex, who was a member of the Council of the College and later
President. In 1857 Arnott asked the College to establish a dental depart-
ment and, although he was unsuccessful in this, convinced the Council of
the need for a Licence in Dental Surgery. It was left to the " Memorialists,"
as they were called, to secure that an enabling clause was inserted in the
Bill which became the Medical Act of 1858. A Member of Parliament
promised to see to this but failed to do so. Tomes did not learn of this
until the eve of the last day on which notice of motion was required : he
had to awaken the College solicitor at 5 a.m. to draft the clause which
enabled the Charter to be given. It is interesting that Tomes himself did
not become a Member of the College until 1859. The first examination for
the Licence in Dental Surgery was held in March 1860 (Fig. 2) ; the dental
examiners were John Tomes, Thomas Bell and Arnold Rogers, who
examined themselves : there were forty-three candidates, all of whom
were successful. Professor Wilkinson tells me that the curriculum that
was devised in 1860 remained in all essentials unaltered until 1922.

This then was the background in which the Odontological Society
established the Dental Hospital of London, afterwards the Royal Dental

Hospital, in the house in Soho Square which had been the residence of Sir Joseph Banks, President of the Royal Society. The College of Dentists, led by James Robinson, replied by founding the Metropolitan School of Dental Science in Cavendish Square, later to become the Dental School of University College Hospital. Before the end of the century most of the other dental schools had been established ; degrees in Dental Surgery were instituted by the Universities of Birmingham and Leeds, and others followed ; in due course most Universities instituted the higher degree of Master of Dental Surgery ; Manchester was the first to confer a Doctorate.

Fig. 2.　Fees received at the first examination for the Licence in Dental Surgery.

Samuel Cartwright was appointed the first Professor of Dental Surgery at King's College Hospital in 1860. He was an exquisite ivory carver and reputed to enjoy an annual income of £10,000. His sponsors for election as a Fellow of the Royal Society included Astley Cooper, Richard

Owen, William Sharpley and Benjamin Brodie. It was not until sixty-two years later that the first endowed Chair in Dental Surgery, to which W. H. Gilmour was appointed, was established at the University of Liverpool.

Women have practised dentistry from ancient times. In 1754, Fielding, the novelist, sent for an eminent female toothdrawer of Wapping to relieve his wife of toothache before they set sail for Portugal. In 1866 Miss L. B. Hobbs, the first woman to obtain a dental qualification, received her Diploma from the Ohio College of Dental Surgery. The first woman to qualify in the United Kingdom was Dr. Lilian Lindsay, who became a Licentiate of the Royal College of Surgeons of Edinburgh in 1895. It was not until 1908 that the Royal College of Surgeons of England decided to admit women to examinations for the Licence in Dental Surgery : the first was conferred in 1913.

In 1920 the Royal College of Surgeons of Edinburgh instituted a higher Dental Diploma and the Royal Faculty of Physicians and Surgeons of Glasgow followed suit the same year. In 1930 the University of St. Andrews approved the requirements for a Diploma in Public Dentistry. Writing in the *Lancet* in 1841, J. L. Levison had urged the desirability of a Faculty of Dental Surgery and in 1891 J. M. Acland stressed the need for a higher dental diploma. In 1911, if not before, it was suggested that this College should institute a Fellowship in Dental Surgery. A Charter, which empowered the College to give a Fellowship in Dental Surgery, and establish Faculties in the College, was granted on 20th May 1947. The only Faculty specifically mentioned is that of Dental Surgery. The first meeting of the Faculty was on 31st July 1947 and the first examination for the Fellowship in February, 1948.

In 1875 the Dental Reform Committee, later to become the Representative Board of the British Dental Association, was set up with the object of securing a Register for the profession. The Dentists Act of 1878 established the Register and placed the responsibility for maintaining standards of dental education on the General Medical Council. The Act protected title but did nothing to protect the public from the unskilled. Indeed, in his address to the first session of the Dental Board, Mr. (later Sir) Francis Dyke Acland observed that some persons had been admitted to the Register in 1878 who could only at the time have been engaged in the practice of dentistry " by assisting at the removal of their own milk teeth."

Abuse was rife and in July 1917 the Lord President appointed a Departmental Committee to consider the position and to recommend legislation : this led to the Dentists Act, 1921. In their Report of 5th February 1919, the Committee recommended that the Dental Board should be set up although the General Medical Council should retain certain responsibilities, including dental education ; the Committee advised, however, that " . . . as much self-government of the dentists should be effected as is practicable. . . . "

In April 1943, the Interdepartmental Committee on Dentistry was appointed under the Chairmanship of Lord Teviot. This Committee recommended that a comprehensive dental service be provided within the National Health Service, with priority to be given to children, nursing and expectant mothers and to hospital patients, that dental recruitment be materially increased and that an independent General Dental Council be established. Effect was given to this last recommendation by the Dentists Act, 1956.

Reviewing the work of the Dental Board of the United Kingdom at its closing session in May 1956, Sir Wilfred Fish was able to say that as a result of the Board's efforts dental schools had been encouraged to appoint whole-time professional staff, an academic cadre had been established and teaching in dental schools systematized. Students were beginning to read for degrees rather than diplomas ; grants had assisted building and in the purchase of equipment : bursaries and loans had been given, a Post-graduate Bureau established whose Director had done much to encourage and assist post-graduate studies. As early as 1923 the Board had given grants to assist dental research and they continued to do so until the out-break of war. A useful contribution had been made to the dental education of the public. He recorded our indebtedness to the Registrars, Norman King, Michael Heseltine and David Hindley-Smith.

In March 1955, a Committee was appointed under the Chairmanship of Lord McNair to consider recruitment to the dental profession. He made a number of important recommendations which included an increased entry to the dental schools and the institution of a comprehensive programme of dental health education.

The postgraduate lectures and the course sponsored by the Dental Board, the activities of its dental postgraduate bursars, and the grants made to assist overseas students have been of very real value. Special mention should be made also of the courses organized at East Grinstead and by the Ministry of Health, those conducted by this College and at the Institute of Dental Surgery and Eastman Dental Hospital.

At the instigation of Lord Nuffield, Dental Surgery was one of the first fields of study to be considered by the Trustees of the Nuffield Foundation, and we must acknowledge with gratitude the very great value of the generous assistance given. Recognizing the need to apply new knowledge in the basic sciences to dental problems, the Foundation has given every encouragement to dental students and teachers to study the basic sciences and to those trained in these disciplines to devote themselves to dental teaching and research. Grants from the Foundation have enabled Universities to augment pre-clinical staff, improve teaching, initiate or extend fundamental research, and develop methods of ensuring positive dental health and the prevention of dental disease. A review of the advances made in dental surgery since the war will show how much of this can be directly or indirectly attributed to the vision, encouragement and help of the Foundation and its Director, Mr. L. Farrer-Brown.

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History shows the importance to us of the basic sciences. A ter studying chemistry at the University of Michigan, Willoughby M. ler read Natural Philosophy at Edinburgh. If the climate had been kinder he might have remained : as it was, he went to Berlin to continue his studies : here he became friendly with two American dentists at whose instance he returned to the United States to train as a dental surgeon. Back in Berlin he came under the influence of Robert Koch, the bacteriologist, and engaged in the investigation which led in 1884 to his " chemico-parasitic " theory. It is of interest that some three hundred years before the Christian era, Aristotle wrote that " figs and sweets produce damage to the teeth because small particles adhere between, where they become the cause of putrefacted process." In 1835 William Robertson of Birmingham suggested that sticky food remaining on the occlusal and interstitial surfaces of the teeth produced decay. And we still eat more sweets than any other country in the world !

G. V. Black was the son of a farmer and was self-taught. He studied chemistry before turning to dental surgery. His study of caries in 10,000 teeth, on which he based his classification of cavities and the theory of extension for prevention, is reminiscent of Hunter's work on bees. His investigation of amalgam and the effects of fluoridation are too well known to require mentioning, but you may not remember that in 1892 Sir James Crichton-Browne had suggested that the presence of fluorine as a trace element might decrease liability to dental caries.

It is clear that, notwithstanding the encouragement given by the Dental Committee of the Medical Research Council, we are devoting insufficient time and effort to fundamental dental research, although the investigations of the Department of Dental Science in the College under the inspiring leadership of Sir Wilfred Fish, the splendid endowment of a Research Chair by our great benefactor, Lord Nuffield, and the generous help of the Leverhulme Trust will, and indeed have already more than justified our high hopes and our confident belief in the future.

We know that Matthew Flint, toothdrawer of London, was appointed by Henry IV to do " all that pertains to his art to any of our poor subjects " for sixpence a day for life. Fees appear to have improved since then for Hunter is said to have received five guineas for transplanting a live tooth and two guineas for a dead tooth, and Berdmore, who was appointed Operator for the Teeth to George III at the early age of twenty-six died of gout less than twenty years later, leaving the tidy sum of £40,000. Lesser men like Mr. Orme who practised next to the Middlesex Hospital had to be content with from five pounds for a denture : five shillings to half-a-guinea cannot be regarded as exorbitant for freeing the gum from a scorbutic humour.

You have heard how practitioners would treat poor patients without fee : after the turn of the century, the British Dental Association organized clinics where working men and their families could receive good treatment at fees that they could afford. Boards of Guardians employed dentists,

mostly part-time, to treat the aged and sick in their institutions, and after the passing of the Local Government Act of 1929, Public Assistance Schemes for dental treatment were instituted. The National Health Insurance Act of 1911 provided for manual workers and those earning less than £250 per annum, but not for their dependants. Dental benefit from accumulated surplus funds was introduced about 1922 and proved most popular although few societies were able to pay more than half the cost of treatment ; on average not more than 7 per cent. of those entitled sought dental care in any one year, so that when the National Health Service came into being on 5th July 1948, few can have expected the overwhelming demand for dental treatment. Indeed, during the first year nearly eight million courses of treatment were given, and it is to the greatest credit of all concerned that the treatment sought was provided. This is not the time or the place to assess the dental provision under the National Health Service, but there can be no doubt at all that it has provided treatment—and good treatment—for many who could not have otherwise obtained it.

In 1886 George Cunningham of Cambridge urged that lectures be given to the public on dental health : he himself gave talks on the subject. Although the Dental Board and other bodies have made valuable contributions to making the public conscious of the importance of oral health, nothing on a nation-wide scale has been attempted. Now, however, the Committee recommended by Lord McNair is to consider the problem ; they will do well to study the approach made by our forbears, who had nothing to learn from the advertising copywriters of today. The approach to men was direct but for ladies there was a different line. This is by Edward Breham, Surgeon-Dentist of Leeds : ". . . many ladies owe the acquisition of a husband to the attraction of a beautiful set of teeth. Without these the most regular features are uninteresting, if not repulsive. The lustre of the most brilliant eyes, the fascination of the most graceful figure, are marred by the very smiles which a good set of teeth would have rendering captivating. The prettiest lips concealing the defects of disease within them repel those whom they would have otherwise delighted."

William MacPherson Fisher of Dundee obtained the Licence in Dental Surgery of this College in 1877. In 1885 the British Dental Association held its Annual Meeting at Cambridge when Fisher read a paper on " Compulsory attention to school-children's teeth " ; George Cunningham was in his audience. Three years later Fisher asked the British Dental Association for a grant of £10 towards the cost of a field survey on the dental condition of children, and in March 1896, the British Dental Association appointed a committee to continue the investigation. Dr. Senior has compared the findings of that committee between 1890 and 1897 with those of recent surveys and concludes that the incidence of dental caries in school-children has doubled in England and more than doubled in Scotland.

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Cunningham, who was a member of the committee, spoke on the subject at the first International Dental Congress in 1890, where he interested Ernst Jessen who established the first school dental clinic in Strasbourg. In this country the first school dental appointment was to the North Surrey District schools at an annual salary of £60 ; there were thirty candidates for the appointment. The Local Government Returns show that by 1894 dental surgeons were employed at eleven London schools. Each child was to be given a tooth-brush and was to see the dental surgeon twice a year.

Cunningham interested Sedley Taylor, a wealthy patient of his, in his project to establish a school dental clinic at Cambridge, and Mr. Taylor agreed to finance it. The Cambridge Dental Institute for Children, the first of its kind in this country, opened in November, 1907. Cunningham became the Honorary Director and, after the first few weeks, A. W. Gant was appointed dental surgeon. It is to his enthusiasm and devotion that the Cambridge Clinic owed its original success. It would be gratifying to tell you that Fisher's hopes have been realized but it would be far from true. In fact about one-third of the child population of this country do not receive dental treatment in any one year.

Cunningham found that the disease known as "phossy jaw," from which matchworkers then suffered with deformity and often fatal results, did not occur unless there was dental caries or lack of oral hygiene. The Home Office appointed him a Government Inspector so he had access to those factories and, on his advice, regulations were made requiring the appointment of a dental surgeon to attend the teeth of the workers in every one of the factories concerned.

In 1905 Cadbury's instituted a scheme of dental care for juvenile employees and shortly afterwards made dental fitness a condition of employment. The following year Peek Frean appointed a part-time dental surgeon to provide free dental treatment for 2,400 employees, and other enlightened firms such as Marks & Spencer organized similar schemes.

The inception of the National Health Service saw the development of general and consultant dental services in hospitals and there are but few hospitals remaining in which there is no provision for dental care, although it has not yet been possible to provide a fully comprehensive service.

In 1676 Richard Wiseman gave the first description of a gun-shot wound of the jaw : and after the Battle of Waterloo a report on maxillo-facial injuries was issued. In 1884 Newland Pedley read a paper on the treatment of fractures of the mandible to the Odontological Society, but it was not until the war of 1914-1918 that Sir Frank Colyer, Sir Harold Gillies, Victor Kazanjian, Sir William Kelsey Fry and Warwick James laid the foundations of maxillo-facial surgery as we know it today. When the last war appeared imminent and the Emergency Medical Service was being organized, Sir Harold Gillies and Sir William Kelsey Fry were asked

to take charge of Maxillo-Facial Units, and it is to them and their staff that we owe nearly all of the developments in this field.

Fauchard is said to have been the first to practise orthodontics; he used bands and ligatures to correct irregularities. Both Cartwright and Tomes described the ribbon arch. In paying tribute to Angle's great contribution to the subject, we should not forget Sir Norman Bennett's analysis and classification of the causes of malocclusion, George Northcroft, who was responsible for the inception of the British Society for the Study of Orthodontics, Brash, Harold Chapman, Broadbent, Sheldon Friel and Harold Watkins, all of whom have materially influenced thought in this field.

Tooth-brushes with horse-hair bristles were in general use in the seventeenth century; Fauchard thought them too rough and considered that a moistened sponge was preferable. Mouth washes, tooth pastes and powders were widely used : some of them were said to be so complex as to take more than two weeks to prepare. When Fauchard recommended the removal of tartar with very great care and cutting the excess gum with scissors, he did not realize that he had become the first periodontist, unless of course we give priority to the Romans who ligated or splinted loose teeth. The first clinic for the treatment of periodontal disease was established at the Royal Dental Hospital in July 1932 by Sir Wilfred Fish, who had been studying the work of Gottleib of Vienna.

Partial dentures of bone, ivory or boxwood were known to the Romans. In the eighteenth century hippopotamus ivory was considered to be the most durable, elephant ivory inferior to this, while bone was used only for the most inexpensive dentures. It usually took about six weeks to carve a denture. As late as 1875, a London firm kept ivory blocks for the purpose. Goldsmiths were employed to rivet teeth to the ivory or bone base, and later they were asked to swage a gold base. Pilleau made dentures to wax impressions taken by the patient. Gold, however, was very expensive and platinum, then less costly, and later cast tin were used as substitutes. This did not please everyone and as late as 1860 Gray spoke of the beauty of hippopotamus ivory and the terrible consequences of using gold in the mouth as it would set up electric currents which would destroy the palate and throat.

The story of the chemist Duchâteau who, because his dentures became badly stained with the prescriptions he had to taste, thought of having his dentures made in porcelain is well known. But Guerhard, the porcelain manufacturer to whom he went, was unable to overcome the contraction during firing. He then consulted Nicholas Dubois de Chemant, a surgeon who was successfully practising as a dentist in Paris; Darcet, the Assayer of the French Mint, arranged for de Chemant to have access to the Sèvres porcelain factory, where a small furnace was built for him. By lowering the firing temperature, de Chemant was able to reduce the contraction, although the dentures were very friable. He obtained letters patent for his process from Louis XVI in 1789; Duchâteau

brought an unsuccessful action against him. When the Revolution took place de Chemant came to England because, it was said, of the jealousy of his colleagues who accused him of having stolen Duchâteau's invention. He practised in Frith Street, Soho, and took out patents for his process in 1791.

At the beginning of the nineteenth century, natural teeth were used for dentures. These were mostly supplied by grave-diggers ; Victor Hugo describes a man going over the battlefields of Waterloo looking fo. teeth. But sound human teeth were scarce and expensive and animal teeth unsatisfactory. In 1808 Fonzi, an Italian dentist practising in Paris, invented single teeth which were slotted and mounted on posts. Corbett brought particulars of these to Claudius Ash, a goldsmith, who made dentures for a number of dentists. Ash, who almost beggared himself by his research, eventually produced a translucent gold tube tooth. About 1830 Charles Goodyear, an American hardware merchant, accidentally discovered vulcanite. Thomas Evans made him a denture of the material, showing Goodyear's son the method he used ; the son patented this in 1855 and issued licences to dentists who wished to use the material. In 1879 Josiah Bacon, the Treasurer of the Goodyear Company, was killed by a dentist he had prosecuted for infringement. The patent lapsed in 1881.

Drugs and intoxicants had been used to induce insensibility to pain since the earliest times. Matthew Turner, a Liverpool surgeon, recommended the inhalation of ether to relieve pain in 1743. Although Crawford Long, a medical practitioner, had used ether anaesthesia to incise a boil in 1842, he did not publish his discovery. In December 1844 Dr. Riggs, who gave his name to Riggs' disease, extracted a tooth for Wells, who was a dentist, at his own request ; Colton, a popular lecturer on scientific subjects, administered nitrous oxide. Unfortunately a demonstration that Wells gave at the Massachusetts General Hospital was not convincing and he was discredited. W. T. Morton, another dentist who was present, consulted Dr. Jackson, a physician and chemist, about the manufacture of nitrous oxide. Jackson suggested ether as an alternative, which Morton used successfully. Unfortunately bitter quarrelling and litigation between Wells and Morton, and later between Morton and Jackson, followed. Wells ultimately took his own life.

James Robinson was the first President of the College of Dentists. He was Surgeon Dentist to Prince Albert and to the Metropolitan, afterwards the Royal Free Hospital. On 19th December 1846, he extracted a tooth painlessly under ether anaesthesia, administered by his friend Dr. Francis Boot. Lord Lister was interested and asked Edwin Saunders, who was Dental Surgeon to Queen Victoria, to try it. A patient requiring an extraction volunteered but after the first inhalation said that his toothache had gone and would not go on. Alfred Coleman, who was related to Lord Lister by marriage, collaborated with Clover at the Royal Dental Hospital

in producing apparatus and technique for maintaining prolonged anaesthesia.

Alexander Wood of Edinburgh injected morphia to relieve neuralgia in 1843 ; Rynd of Dublin is said to have done so earlier. In 1864, during the American Civil War, F. Carlin, an Army surgeon, operated on a soldier with a jaw injury under analgesia produced by a local injection of a grain of morphia. Halsted of New York was the first dentist to use cocaine, which he injected into his own inferior dental nerve.

Roentgen discovered X-rays in November 1895. The following March the *Pall Mall Gazette* observed that : " . . . it appears that you can see other people's bones with the naked eye and through eight inches of solid wood. On the resulting indecency there is no need to dwell."

In the United States, a Bill was introduced prohibiting the use of X-rays in opera glasses in the theatre and an English firm advocated X-ray-proof clothing for the modest maiden. In 1896 Frank Harrison in this country, Edmund Kells of New Orleans, and W. Koenig of Frankfurt demonstrated dental radiographs.

In 401 B.C. a Greek general had to withdraw his army from Asia because so many of his soldiers were affected with sore mouths and foul breaths. This appears, however, to have made little impact on military history for we find William MacPherson Fisher urging the need for dental care of the Navy and Army unheeded. In 1887 George Cunningham joined in, and later we find William Guy vigorously campaigning for the establishment of an Army Dental Corps. At the outbreak of the 1914-1918 war, Cunningham with remarkable foresight sought to persuade the War Office to provide a mobile dental unit complete with X-rays and electrical equipment.

In 1892 Staff Surgeon Canton, a medical officer who had a dental qualification, began minor dental work at the Royal Naval Hospital, Haslar ; seven years later two other staff surgeons were detailed to instruct medical officers in dental surgery so that they could give dental treatment on board ship. In 1900, Mr. Sydney Garne was given this responsibility, and four years later whole-time civil dental surgeons were appointed, some eight of whom went to sea during manoeuvres. In 1915 some of these were commissioned in the Royal Navy Volunteer Reserve, and in 1920 in the Royal Navy Dental Service. Surgeon Lieutenant (D) Edward Fletcher was appointed Dental Assistant to the Medical Director General, later to become Surgeon Rear-Admiral Fletcher, Deputy Director General for Dental Services. In more recent years the appointment of Director of Dental Studies and Research has been established and Professor Martin Rushton has been appointed Consultant Dental Pathologist to the Royal Navy.

In 1626 as an inducement to the recruitment of Army surgeons, Charles I authorized the issue of a free instrument chest which included in its contents eight dental instruments. At the outbreak of the South African war in 1899 no provision had been made for the dental treatment

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of forces in the field, and nearly 5,000 were found unfit for duty because of their dental condition ; over 2,000 had to be sent back to England. Representations made to the War Office by the British Dental Association that the troops were unable to eat their rations because of their dental condition only resulted in the issue of mincing machines. In 1900 Newland Pedley went out to South Africa for six months and in 1901 four civilian dental surgeons were appointed. From 1903 to 1908 J. H. Badcock, W. A. Maggs and M. F. Hopson gave dental instruction to Royal Army Medical Corps officers at Guy's Hospital. Three whole-time dental surgeons were appointed in 1908 for the treatment of the troops in India. One of these, J. P. Helliwell, was appointed to the War Office in an advisory capacity in 1918 and became Director of the Army Dental Service when it was established in 1921. In 1946 it became the Royal Army Dental Corps.

During the 1914-1918 war, the Royal Flying Corps received dental treatment by arrangement with the Army Medical Authorities and this continued during the early years of the Royal Air Force until 1st July 1930, when the Royal Air Force Dental Branch was formed. Air Commodore L. Somerville-Woodigus became the first Director. In 1943, on the advice of Sir William Kelsey Fry, the Royal Air Force decided to train and employ dental hygienists and in 1953 the Royal Army Dental Corps established a training centre for them at Aldershot. The experimental training of dental hygienists, recommended by the Teviot Committee, began the Eastman Dental Hospital in November 1949. So successful were they that they were employed in the Public Dental Service and in August 1957 were permitted by regulations to accept employment in private practice.

When the Dentists Act 1878 was passed, the Dental Reform Committee became the Representative Board of the British Dental Association, although the Association itself was not formally constituted until May 1880. Its first meeting was held on 26th July at the Royal Dental Hospital under the Presidency of John Tomes. In 1949 the British Dental Association amalgamated with the Incorporated Dental Society and the Public Dental Service Association to form a single professional organization. The first dental society to be founded in England was, as you have heard, the Odontological Society of London, which came into being in November 1856 with Samuel Cartwright as President. In 1907 the Royal Medical and Chirurgical Society formed the Royal Society of Medicine and the Odontological Society became the Section of Odontology. The American Dental Club of London, formed on the initiative of George W. Field in 1895, was succeeded in 1908 by the American Dental Society of London ; Dr. Leon Williams was among the founder members. The International Dental Federation was founded at the International Dental Congress which met in Paris in 1900. Dr. Charles Godon became President and the first meeting was held in Cambridge the following year. With the exception of the International Red Cross, the International

Dental Federation is the oldest international health organization in the world. Forty-five countries are affiliated to it and it is recognized by the World Health Organization of the United Nations. Largely as a result of its efforts, the World Health Organization now has a whole-time Dental Officer and finances an international dental programme. Tribute must be paid to the late Mr. Rowlett and to Charles Nord and G. H. Leatherman who have devoted themselves so whole-heartedly to the work of the Federation.

The term " filling " did not come into use until about 1830 although lead, tin and gold foil had been used for this purpose since ancient times. Fusible metal was melted at the temperature of boiling water and poured into the cavity ; later mercury was added to lower the melting point, which led to Taveau of Paris using an amalgam of mercury and silver filings. This required much less skill to manipulate, although as a result of its uncontrolled expansion fractured teeth and protruding fillings brought it into disrepute. In 1833 two enterprising and unprincipled brothers named Crawcour from Paris launched themselves in this country and the United States with a publicity campaign for their Royal Mineral Succedaneum, which shocked the most tolerant. So bitter did the "Amalgam War " become that the American Society of Dental Surgeons and other societies expelled members who would not pledge themselves to abstain from using amalgam.

In 1667, after the Great Fire, an Act was passed prohibiting sign-boards being hung across the street but permitting them to be attached to balconies on the sides of houses. As they were heavy and bulky they proved dangerous, so in 1762 an order was made that all signs must be let into the wall of the house and made of stone. This is the origin of the brass plate. The lamp derives from the candle which was often kept burning in a lanthorn in the window at night.

For a long time it was considered best to carry out dental extractions with the patient seated on the floor with his head between the operator's knees. Later the patient sat in an ordinary chair, although a few daring spirits attached a wooden head-rest to it. Although dental chairs were available before 1840, they were not generally used until thirty or so years later. At the time J. H. Badcock started practice, it was said that all a dental surgeon needed to start practice was five pounds' worth of instruments. I shall not speak of the evolution of dental instruments and equipment, for it has been fully described. But Mr. Aiken Watson tells me that basic design, although streamlined, has undergone little change and the century has seen no development of comparable importance to the high-speed and ultra-sonic cutting tools of today.

Some 400 years ago Ambroise Paré confidently declared that after the publication of his work there was nothing left for posterity to add. No one could have the temerity to make such a prediction in our time. What is ahead ? Where will progress come ? I do not doubt that special techniques will be developed and that materials and therapeutic agents

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will make great advances. But it is in the application of new knowledge in the basic sciences, in the better understanding of the causes of oral disease and in the recognition and prevention of the earliest lesions that the future lies.

I have not spoken of the work of our Faculty, although I believe that we have been faithful stewards ; it is for those who come after us to assess it. I do not think that I can end more fittingly than to quote the words of Lord Webb-Johnson, to whom we owe so much. Addressing the first Annual Meeting of the Faculty, he said : ". . . Your Board of Faculty is building on firm foundations and can plan to build high. Your work is certain to be lasting. It will lift dental surgery to a higher plane and will give dental surgeons the opportunity and the inspiration to attain higher scientific and academic objectives. Dental Surgery must have its place not only in great hospitals but in great universities. It must have an academic home of its own and, please God, as a result of the history we make together, you will find that home in the Royal College of Surgeons of England."

Sustained by the authority of this College and encouraged by its Council, Dental Surgery has come a long way since the Charter of September 1859. Truly we have good reason to rejoice.

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HONORARY FELLOWS IN THE FACULTY OF DENTAL SURGERY

AT THE ANNUAL Meeting of the Faculty on 24th July, the President admitted to the Honorary Fellowship in the Faculty of Dental Surgery :

Sir Cecil Wakeley, Bart., Past President of the College

The Rt.-Hon. Lord Cohen of Birkenhead

Sir Douglas Logan, Principal of the University of London.

Citations were delivered by Mr. R. Cocker in honour of Sir Cecil Wakeley, by Professor H. H. Stones in honour of Lord Cohen of Birkenhead, and by Mr. F. S. Warner in honour of Sir Douglas Logan.

Sir Cecil Wakeley replied on behalf of the three newly elected Honorary Fellows.

ELECTIONS TO THE F.D.S.R.C.S.

THE FOLLOWING WERE admitted to the Fellowship in Dental Surgery by election at the Annual Meeting of the Faculty on 24th July :

Mr. William Earle, of St. Mary's Hospital

Dr. Don Gullett, of Toronto

Dr. Paul Jeserich, of New York

Dr. W. Scott Hamilton, of Edmonton, Alberta.

TREATMENT OF THE CLEFT PALATE

SCIENTIFIC SYMPOSIUM
held at
the Royal College of Surgeons of England
on
24th July 1959
under the Chairmanship of
Sir William Kelsey Fry, C.B.E., M.C., F.R.C.S., F.D.S.R.C.S.Eng.

THE DEVELOPMENT OF CLEFT LIP AND PALATE
by
W. R. Burston, Ph.D., D.Orth.R.C.S., L.D.S.
School of Dental Surgery, University of Liverpool

AN UNDERSTANDING OF the development of cleft lip and palate must rest on knowledge concerning the normal development of the face and jaws. The study of the development and growth of these structures sweeps across a wide field of ontogeny, starting in the earliest weeks of pre-natal life and extending through the incident of birth, until early adulthood. Such study therefore attracts the attention of many workers ranging from the experimental embryologist, interested in the early migration of cells, to perhaps the surgeon or orthodontist treating a clinical condition in late adolescence. Only too often the experimentalist has had but little sympathy or even acquaintance with the practical problems confronting the clinician whereas the latter may remain unimpressed in face of evidence adduced from amphibian larvae.Yet the whole story is one and the most recent advances have been achieved by the fuller and freer interchange of ideas between these various fields of endeavour.

Classical theory of facial development rests on the work of Durscy (1869) and His (1892) in the latter part of the nineteenth century. This theory postulates the existence of individual facial processes, " fingers " lying free in space, which fuse during development by the degeneration of their ectodermal covering layers. This theory has persisted and is taught even to-day. It has the merit, in the present context, of providing a ready explanation for clefts of the lip and face, by ascribing such defects to a failure of fusion. Unfortunately it is not supported by a study of the embryological processes involved or a critical appraisal of the few human cleft lip and palate embryos available for investigation.

Modern embryologists, notably the late Streeter (1951) and his colleagues of the Carnegie Institution at Washington have made intensive and far-reaching investigations into the normal development of the human face. Following this work it has become realized that the facial processes consisted of mesodermal masses migrating forward between the ectodermal covering of the face and the roof of the oral cavity. In this way no ectodermal fusion is called for but rather a smoothing out of ectodermal grooves by the expanding mesoderm beneath.

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This work is supported by the observations of Veau (1938), Hoepke a.id Maurer (1938) who investigated four very rare human embryos with cleft lip and palate conditions. More recently (1954) Stark has review ed this work and added thereto his own observations based on five more hitherto undescribed human embryos with this condition.

The development of cleft lip and palate involves two distinct phases, namely:

(a) The events leading up to the actual formation of the cleft of the lip and palate.

(b) The subsequent growth of tissues which have become malrelated consequent on cleft formation.

The most convenient way of describing the first phase is to follow the early development of the face to the point at which cleft formation might occur.

The ovum is usually fertilized in the Fallopian tube after which it descends into the uterus and becomes embedded in the endometrial wall. The subsequent changes are well described in standard texts and we are concerned here with the situation at twenty-one days when, as a result of the very rapid growth of neural tissue, the original trilaminar embryonic
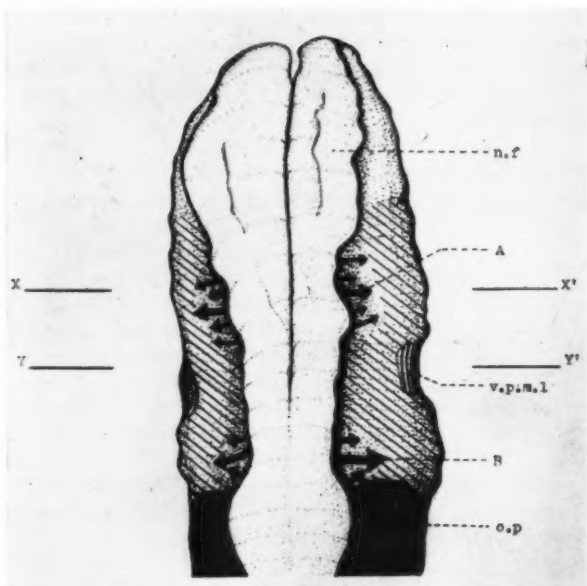
Fig. 1. Graphic reconstruction, dorsal view, of a twenty-five-day mammalian embryo. The arrows A, B, indicate the regions of outflow of neural crest material. O.p=otic placode. XX', YY' refer to histological sections shown in Figs. 2a, b.

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disc is folding up to form the definitive embryo. The neural folds come together on the dorsal aspect to fuse and form the neural tube. At this stage certain cells are extruded from the neural crest and these migrate down the side wall of the head (Fig. 1). Many of these cells are referable to the cranial ganglia, but others continue to pass downwards thereby thickening the pharyngeal wall. Since this outflow is segmental, the thickening of the pharyngeal wall will likewise be segmental and in this way the pharyngeal arches are produced (Figs. 1 and 2 *a* and *b*).

(a)   (b)
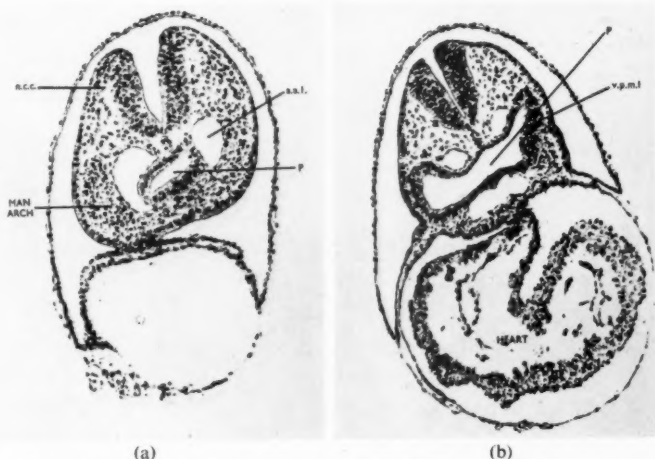
Fig. 2 (*a*). Histological section through plane XX' (Fig. 1) showing the discontinuity of the basement membrane at the neural crest and the outflow of crest cells down the side of the head to form the first visceral arch. Note the narrow pharynx in this region and the large first arch artery.

(*b*). Histological section through plane YY' (Fig. 1). Note the continuity of the basement membrane at the neural crest, the " open " unorientated mesoderm, and the wide expanded pharynx which approaches the overlying ectoderm to form the first visceral pouch membrane. The lateral expansion of the pharynx foreshadows the tympanic tube and the membrane will become the ear drum. aa l = First arch artery. m.c.c = migrating crest cells. P = pharynx. v.p.m l = First visceral pouch membrane.

Proof of this origin and migration of visceral mesoderm has been adduced from experimental work on amphibia which having free living larvae are well suited to this approach. A full review of the elegant and precise experiments performed has been given by Horstadius (1950).

In amniotes, technical difficulties have largely precluded experimental investigation and confirmation in this group has had to rest on histological examination of very close series of embryos. Burston (1953) working on the sheep was able to demonstrate a marked correlation with the experimental findings in lower forms. In man the problem is again more difficult for lack of sufficient specimens at the critical stages. However, Streeter

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was able to conclude from the wide collection of human embryos at his disposal that the concept was also valid for man.

We are concerned here with the mandibular arch and once this has been formed with the secondary extension of mesoderm which takes place around the angle of the primitive stomatodeum. This mesoderm migrates forward in the angle between the ectodermal covering of the face and the roof of the oral nasal cavity (Fig. 3) to form the maxillary process.

However, on either side of the face there are two residual areas where the ectodermal coverings of the face and that of the oral cavity (in its
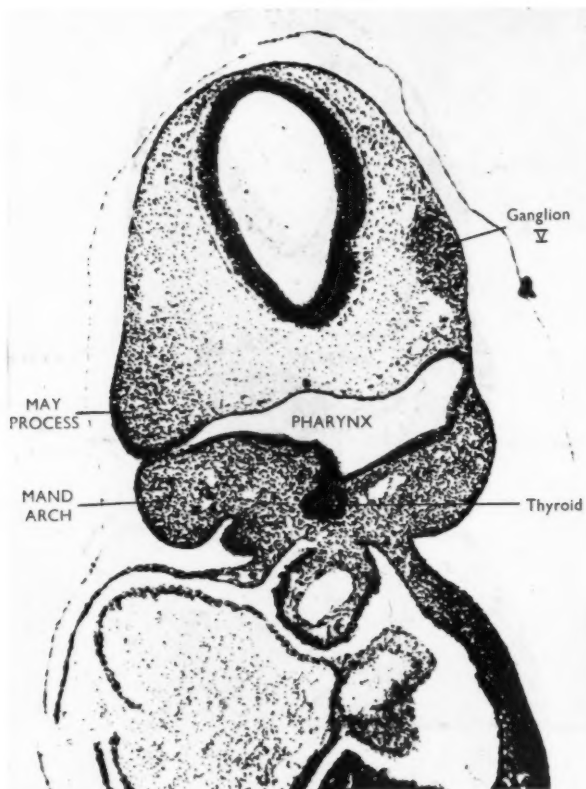
Fig. 3. Frontal section through the head of a twenty-eight-day mammalian embryo. (Note this section is somewhat oblique.) The mesodermal condensation of the mandibular arch is well shown and on the left side can be seen the maxillary extension of this condensation forming the maxillary process. Other features of interest are the early formation of the trigeminal ganglion and the developing thyroid bud.
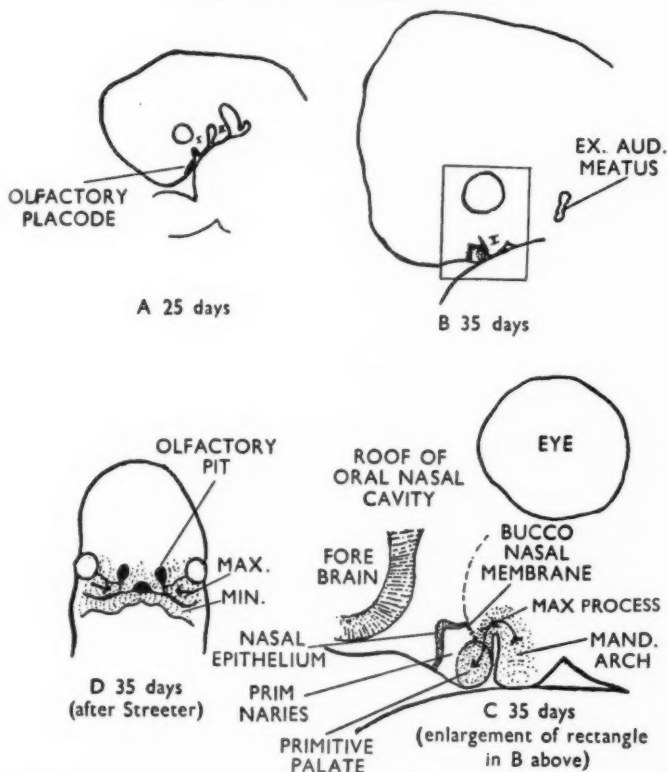
Fig. 4. Diagrams of human embryos showing the formation of the primitive palate and respiratory by-pass. A, B and C are to be regarded as embryos which have been rendered translucent to show the olfactory placodes and mesoderm underlying the surface ectoderm.

A. Lateral view of embryo at twenty-five days to show the formation of the olfactory placode and visceral arches I and II.

B. Lateral view of embryo at thirty-five days (same scale as A) to show the great increase in size of the head and the associated " sinking in " of the olfactory placode by a process of differential growth.

C. Enlarged view of the area included in the rectangle in diagram B. This shows the way in which the maxillary mesodermal extension passes first along the side of the head (Fig. 3) and then medially beneath the olfactory pits to join its fellow of the opposite side. In this way the primitive palate is produced. Note the bucco-nasal membrane, breaking down to form the primitive naries, opening in the front of the oral nasal cavity.

D. Frontal view of thirty-five-day embryo to show the pear-shaped olfactory placodes and the maxillary processes of underlying mesoderms passing forward towards the mid line, thereby forming the primitive palate and excluding the placodes from the lip. Failure of one or both of these extensions will cause the placode(s) (future nostrils) to break through the primary palate and so produce a cleft(s) of the alveolus and/or lip.

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most anterior part) remain close together. Rapid proliferation of ec o-
derm occurs and these areas become the olfactory placodes (Fig. 4).
They are somewhat pear-shaped in outline as seen from the front w th
the narrow part extending downwards to involve what will be the lip.
As the adjacent mesodermal extension from the mandibular arch (the
maxillary process) continues to grow, the contour of the face takes on the
characteristic bulges of the facial processes and the olfactory pits appear
to sink in to the face. These events have been well figured and described
by Streeter (1948a).

We are now concerned with the fate of the olfactory placodes, particu-
larly in their most dependent portions which potentially involve the lip.
Ectoderm requires the support and nutrition of underlying mesoderm if it
is to survive, hence the whole of the olfactory placode would be in danger
of breaking down, were it not for the fact that in normal development a
part of each maxillary process passes beneath the main upper portion of
the placodes, thereby penetrating the ectoderm and forming a bar of
tissue which is the primitive palate (Fig. 4c, d). The upper portion of the
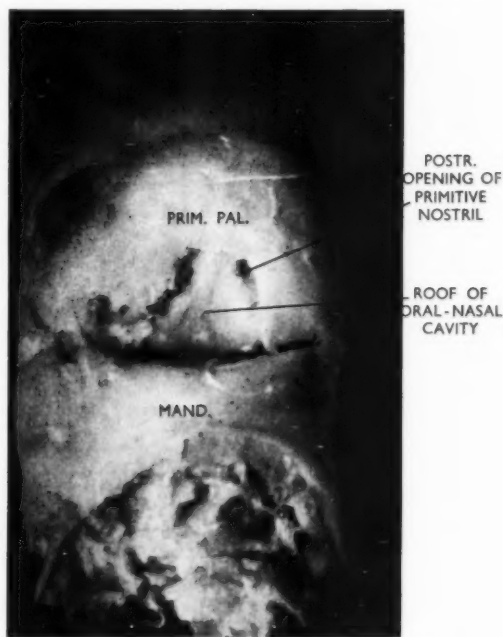
Fig. 5. Five-week human embryo to show the massive primitive palate and the posterior choanae of the primitive respiratory by-pass opening into the roof of the oral nasal cavity.

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olfactory placodes continues as thin double membranes, which are now known as the bucco-nasal membranes, and these eventually break down to form the two primitive nostrils (Streeter, 1948b).

The formation of the primitive palate is complete by five weeks (Fig. 5) and from this structure is derived the upper lip and premaxillary region of the maxillary complex as far back as the naso-palatine canals, which for practical purposes may be taken as the region of the incisive foramen.

It follows that should there be a failure of either or both of the maxillary processes to extend beneath the olfactory placodes, break down (either partial or complete), of the primitive palate would be expected. Stark's observations have demonstrated that in cleft lip embryos, there is in fact failure of mesoderm on the affected side(s).

Clearly the actual position and extent of the cleft(s) will depend on the degree of failure of the mesodermal extensions.

It is possible therefore to distinguish clefts of the primary palate which, from the clinical standpoint, are seen as clefts of the lip varying from minor notches to involvement of the nostril. These clefts may be either unilateral or bilateral, and may or may not involve the alveolar process in the incisal region.

Although clefts of the primary palate are frequently associated with clefts of the palate proper, they can and do have an independent existence. They must have occurred before the five-week period and they are formed by a breakdown process rather than by a failure of fusion.

The formation of the secondary palate, by the fusion of the maxillary palatal processes with each other and with the inferior border of the nasal septum, is well described in many standard works. Certain points are, however, worthy of emphasis.

1. The palatal folds emerge at about eight weeks, that is, very much later in embryological time than the formation of the primitive palate.

2. These processes are at first vertically disposed on either side of the tongue, but at about nine weeks, consequent on the descent of the mandible, the folds come to lie above the tongue and fuse from before backwards with the nasal septum, to form most of the hard and also the soft palate.

3. This is a true process of fusion involving the degeneration of the overlying ectoderm. Ectodermal remains may be seen in histological sections for a long time after fusion is complete.

Various factors may arise to interfere with this process, among the most probable of which are :

1. When the cleft of the secondary palate is associated with a previously occurring cleft of the primary palate, it is reasonable to postulate that there has been a gross interference with the migration and development of the original maxillary process, so that either or both of the definitive palatal processes are reduced in size and fail to reach the midline.

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2. There may have been failure of the epithelial coverings of the palatal processes and septum to degenerate and hence prevent mesodermal fusion.

3. There may have been a failure in coordination between increase in width of the head as a whole and the development of the palatal process.

4. It is possible, as has been pointed out by Scott (1955), that cyst formation may occur in the degenerating epithelium and that these cysts could break down.

5. In a rather special category is that failure of the mandible, and hence the tongue, to descend may have prevented the palatal folds coming into aposition.

It is believed that this mechanism is probably responsible in those cases of cleft of the secondary palate only where this is also associated with mandibular micrognathia. It forms part of the Pierre Robin syndrome and the embryological correlations suggest that the primary defect is a failure of extension of the original flexure of the cranial case (Burston, 1953 ; 1958).

The above therefore represents a survey of the embryological factors leading to cleft formation.

The cleft can be regarded as Nature's experiment and it now remains to examine the effect of this experiment in terms of subsequent unbalanced growth of the tissues. One of the major factors, if not the principal factor, in the early development of the middle third of the face is the cartilaginous intra-orbital nasal septum (Scott, 1953 ; Kettle, 1954 ;
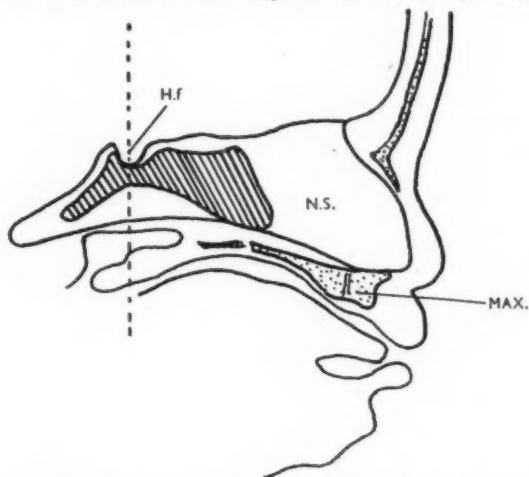
Fig. 6. Mid line section of a full term human foetus to show the size, and relationship of the nasal septum (N.S.) to the maxilla. The superimposed shaded area represents the size of the septum at four and a half months' foetal life. NOTE.—The endochondrial ossifications of the basi-occiput and basi-sphenoid have been omitted for clarity as has also the vomer. H.f=hypophysial fossa.

Glass, 1955-56 ; Burston, 1958).This is an enormous structure throughout foetal life and its importance continues into the first years of post-natal life. During this time the septum is almost entirely intra-facial—a baby has only a small snub nose—yet the septum extends backwards as far as the basi-sphenoid. Figure 6 shows the great increase in this structure from the four months foetal stage to birth. After birth the intra-facial portion of the septum is progressively ossified by the mesethmoid above and from the vomer beneath, the cartilaginous portion growing forward into the face to form the definitive nose. The septum is in intimate relationship with the maxilla (Fig. 6) anteriorly so that growth of the septum will cause a separation of the sutures joining the maxilla to the rest of the skull and hence growth at these sites.

Should, however, one or both sides of the maxillae be disconnected from the influence of the septum by cleft formation, this side(s) will lag behind in antero-posterior and, to some extent, vertical growth. Moreover, the deformity will be progressive so long as the intra-facial part of the septum exerts influence. The septum is particularly active during the last two months of gestation and, after a neonatal pause, continuing into the first few months of life. This, of course, is the rationale for early orthopaedic treatment as by McNeil technique (McNeil, 1954, and Burston, 1958).

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THE SURGERY OF CLEFT LIP AND PALATE

by
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IN RECENT YEARS considerable progress has been made in the operative repair of cleft lip and palate. This has been in a measure due to better understanding of the aetiology and pathology of the condition which has led to a more rational plan of treatment aimed at fulfilling three

important requirements. Operative treatment of these children demands that eventually they must speak well, look well and eat well. They must not reach adult life vocal, cosmetic or dental cripples, for, if they do, they will almost certainly end up as mental cripples.

Improvement in treatment has more than anything else been due to concentration of these cases in specialized units where the efforts of the plastic surgeon, the dental surgeon (both orthodontic and prosthetic) and the speech therapist are united into a harmonious team. The day has passed when the general surgeon was obliged to " try his hand " at the occasional cleft palate and it will fortunately not return.

This symposium brings together the experiences of the plastic surgeon, the orthodontic dental surgeon, the prosthetic dental surgeon and, on this occasion, an anatomist. I am sorry that a speech therapist has been omitted. As it is addressed to a dental audience it could be concerned only with the dental aspect of treatment and how the patient will eat and look, but it would be difficult for a surgeon to regard it from such a restricted standpoint. The total presentation is likely to be uneven for the contributors are drawn not from a single specialized Unit but from several.

The inclusion of the anatomist reminds us that after the first week of foetal development a regular pattern of congenital deformity can be produced by critical stress which may include exposure to X-rays, oxygen or vitamin deficiency, Cortisone intoxication or virus infection as in Rubella. We are, in short, becoming increasingly involved in a study of the cause and prevention of cleft lip and palate as we have long been in its treatment.

My remarks will be confined, however, to problems associated with surgical repair of the condition and I shall attempt to give you a brief résumé of the present position from the surgeon's standpoint.

The lip

The facial deformity associated with congenital cleft lip is not confined to the lip alone. It involves the nose and the underlying facial skeleton. The nose and lip are formed by the harmonious fusion of five components, the median fronto-nasal process, the two lateral nasal processes and the maxillary processes converging from each side. It is not surprising, therefore, that the nose should share in the eventual deformity which is produced by disorganization of this embryological event. Surgical repair of the cleft lip is for reasons of function undertaken soon after birth. In expert hands, the result may approach the normal in appearance and function.

Unilateral varieties

In recent years considerable progress has been made in the primary repair of the lip. The older and simpler methods of Rose (1891) and Thompson (1921) (still preferred by a few) have been supplanted by the angled flap designs of Blair-Brown-Mirault, the quadrangular flap of Hagedorn-

Le Mesurier, and later variations by Marcks, Tennison, Skoog, Millard, Randall and others. Various attempts have been made to deal with the co-existing nasal deformity at the primary operation but, as yet, the repair of this component has not kept pace with the lip repair. Indeed, it is unlikely that in all cases this will ever be possible, for, however perfect the initial repositioning of the alar cartilages may appear, growth and development will only too often produce those well-known secondary defects which demand treatment in the teenage period. At this time the nasal deformity is often worse than the lip scar. It is common ground, however, that whether the alar cartilages are repositioned early or late, nothing should be done to them such as section or apical division which might affect their growth. Any direct attack made early must be simple and radical measures deferred until growth is complete.

At an early stage the nasal deformity is clear, though less obvious than it will later become when the bony and cartilaginous structure of the nose has grown to adult size.

The deformities of the nose and lip which may follow primary repair have been concisely stated as follows :

1. Unsightly scars.

2. Defects of the vermilion border due to mal-alignment.

3. Notching of the lip due to scar contraction and failure to unite the circumoral sphincter correctly.

4. Increased length of the lip at the expense of its width.

5. Flatness and shortness of the upper lip with retrognathism of the upper jaw.

6. Protrusion of the lower lip with prognathism of the lower jaw.

7. Bulging on each side of the scar due to failure of sphincteric union.

8. Irregularities of the nostrils and subsidence of the alar cartilage on the split side.

9. Lateral spread of the alar base on the cleft side.

10. Defects in the floor of the cleft nostril.

11. Deviation of the septum with obstruction of one or both nasal airways.

12. Deflection of the nose towards the sound side (in unilateral clefts).

13. Humping of the nose with depression of the tip due to a short columella.

It can, therefore, be seen that the facial deformity which may be left after the primary operation for unilateral clefts can be considerable, and a formidable proceeding may be required to correct the multiplicity of defects. A satisfactory result may eventually depend upon the proper surgical and dental handling of the underlying maxillary deformity for the general contour of the nose lip complex depends so much upon the integrity or the alveolar arch.

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Bilateral clefts and the problem of the premaxilla

Three schools of thought can be distinguished in this difficult field :

(*a*) The cleft lip on each side is united to the prolabium in one or two stages and the premaxilla allowed to retreat between the halves of the maxilla by the gentle continuous pull of the oral sphincter. There is no interference with the vomerine attachment of the premaxilla.

(*b*) The premaxilla is mobilized by vertical section of the vomer immediately behind the premaxilla which is fixed by a pin between the alveolar processes. Bony union is expected between the premaxilla and the alveolus on each side (Denis Browne).

(*c*) The vomer is partially resected vertically between the layers of septal mucosa at least three-quarters of an inch behind its attachment to the premaxilla. The premaxilla and vomerine complex is moved bodily backwards and fixed as in (*b*) between the alveolar processes (Cronin).

In each case the effort is to reconstitute the alveolar arch complete with four incisor teeth in such a way that an overbite will occur normally and the maxillae will be prevented from collapsing in the centre line.

It must be admitted that without dental aid this rarely occurs. In (*a*) the premaxilla in its backward path usually rotates so that the erupting central incisors point backwards into the mouth, while the laterals erupt into the clefts on each side. Finally the premaxilla often remains mobile and so forms a poor background for incisor function.

In (*b*) damage to the blood supply of the premaxilla by close posterior section of the vomer may result in atrophy of this all-important keystone of the upper dental arch. Collapse of the maxillae follows. In addition the passage of pins through the premaxilla may damage the underlying tooth buds (and usually does). Nevertheless, if lateral bony union occurs so that a new blood supply is achieved, these cases are impressive in infancy.

In (*c*) posterior section and repositioning of the maxilla and vomer has seemed to me to give improved results, though here too the lateral incisors are poor in position and in quality.

If the premaxilla is dealt with according to (*b*) or (*c*) then it should be done at the same time as the primary repair of the lip.

The palate

Whatever the type and degree of cleft in the palate the primary objects of any operation are :

(*a*) To obtain sphincteric pharyngeal control by constructing a soft palate long enough to reach the posterior pharyngeal wall.

(*b*) To obtain closure of the palatal cleft without a fistula or fistulae.

(*c*) To preserve the upper alveolar arch so that the erupting upper teeth will articulate normally with the lowers.

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Whatever the type of palate, whether it be partial, unilateral complete or bilateral, the modern operation as practised in Great Britain is based on the work of Victor Vaux and owes much to the modifications introduced by Wardill. In post-alveolar and bilateral clefts a V-Y advancement is used to lengthen the soft palate. In complete unilateral clefts a four-flap technique is utilized to gain the same end. In both, the post-palatal arteries are preserved but the bony posterior walls of the post-palatine canals are removed to allow the arteries to move backwards (Limberg, 1927). A two-layered closure is effected in the cleft with interrupted catgut sutures placed dorsally on the nasal mucosa and silk sutures on the buccal side.

This type of operation has given excellent results in many hands. Primarily the speech results are good and may not require the services of a speech trainer. More often, however, nothing but good results from the help of this most important member of the team. The amount of damage done to the alveolar arch is probably severe and the inevitable penalty for extensive filleting of the palatal processes is lingual contraction. It is here that the orthodontist and eventually the prosthetist must make his major contribution. An upper tooth which does not articulate with its opposite number is a useless tooth and, if none articulate, the patient is a dental cripple.

The relationship between the surgeon and the dental surgeon should therefore, throughout the treatment of the child, be close. In the very earliest stages the use of sucking plates, as advocated by Fry, should be contemplated, for there can be no doubt that the alveolar arch can be modified by pressure properly applied. After the repair and before the eruption of teeth little can be done dentally, nor can the cooperation of the child be obtained, but the primary teeth should be maintained in good condition. With the appearance of secondary teeth, however, dental cooperation should be sought and maintained until the child is fifteen or seventeen when the final operative phase is reached.

At the slightest sign of lingual contraction of the upper arch expansion should be instituted and carried on until stability is reached. Teeth erupting in bad position, especially in the cleft, can be shifted or rotated but too much time and trouble should not be expended on those teeth (often lateral incisors) which are hopelessly out of line and badly deformed or could have no possible use later in life as supports. They should be removed and replaced with a bridge or removable plate. I have seen much orthodontic work done on teeth of this sort, which, while it may have satisfied the dental surgeon's reluctance to extract what he might call a " sound tooth," did nothing at all to improve the patient's bite, or his dental appearance.

The final correction of secondary defects

When growth is complete the final assessment must then be undertaken, At the age of fifteen to seventeen certain defects will be obvious in nose.

lip, alveolar arch and teeth which can be surgically corrected. Till then and from the dental standpoint the emphasis has been largely orthodontic and a successful result means that the child has a good upper alveolar arch with normal overbite in front and accurate molar articulation behind. All useful teeth have been saved and shifted to functional positions.

In most cases, however, the incisor teeth in the cleft are unsatisfactory, particularly so in bilateral clefts. Cooperation between surgeon and dental surgeon will determine which should be saved and which should be extracted, bearing in mind that a mildly deformed but soundly based tooth erupting in poor position from the premaxilla may still have a useful function later in life when dentures are contemplated.

On the whole, however, I believe that at fifteen to seventeen one should be fairly radical about the incisor teeth if they are ugly, deformed and unevenly placed, especially if the upper alveolar arch is retrognathic. A great deal of the total facial disfigurement disappears if, by suitable extractions, a prosthesis is fitted to correct the retrognathism, carry the lip forwards and expose on smiling an attractive row of incisor teeth. Therefore, depending on the severity of the cleft and the number of involved teeth, I have no hesitation in advising the removal and prosthetic replacement of one to four incisor teeth. Very rarely is it necessary to include the canines.

With this in mind and at this stage, a radical correction of all the nasal and labial defects is undertaken in a single operation combined with extraction of those teeth which stand in the way of a good prosthesis (McIndoe and Rees). The operation is carried out under hypotensive anaesthesia and consists of total repair of the lip combined with a complete repositioning of all displaced nasal elements, sub-mucous resection to clear obstructed airways and nasal reduction to overcome the humped overlong nose is done simultaneously.

Particular attention is paid to the alae which, with this technique, can be made symmetrical. Finally, the patient is fitted with his dental plate designed to bring the lip forward and to carry teeth which look well and articulate with the lowers in correct position.

Thus from birth until the final phase at fifteen to seventeen the surgeon and dental surgeon are closely associated and share responsibility for the eventual result. With this kind of cooperation it is fair to say that to-day the mental cripple resulting from vocal, dental and cosmetic failure is very rare indeed.

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THE ORTHODONTIC TREATMENT OF CLEFT LIP AND PALATE PATIENTS

by

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THE ORTHODONTIST AS a member of the cleft palate team will usually see the baby at its first visit to the cleft centre and unless he carries out presurgical dental orthopaedic treatment he is unlikely to commence any active treatment until the lip and palate have been surgically closed, the deciduous dentition has been established and the cooperation of the child can be ensured.
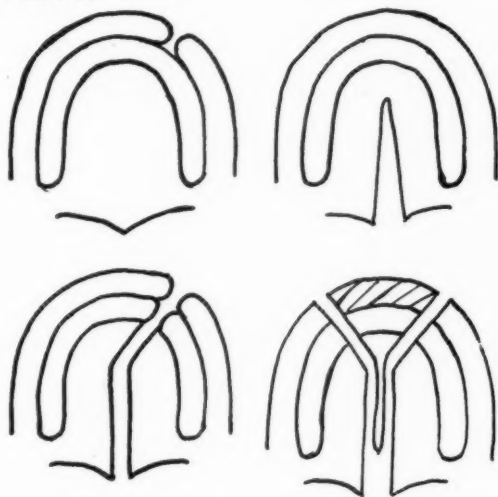
Fig. 1. Diagram showing the four common types of cleft. *Upper:* Cleft lip and cleft palate. *Lower:* Unilateral and bilateral cleft of lip, alveolus and palate.

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The orthodontist, in common with other members of the team, tends to classify clefts according to how they affect his work. Figure 1 shows four main types of clefts.

1. Cleft lip.
2. Cleft palate.
3. Unilateral cleft lip, alveolus and palate.
4. Bilateral cleft lip, alveolus and palate.

It is obvious that those clefts which involve the alveolar arch will present much greater orthodontic problems than cleft of the lip only or palate only, which have intact alveolar arches and which present orthodontic problems in no way different from those malocclusions seen in everyday orthodontic practice.

It will also be realized that unilateral and bilateral clefts of lip, alveolus and palate are the clefts with which the orthodontist is particularly concerned.
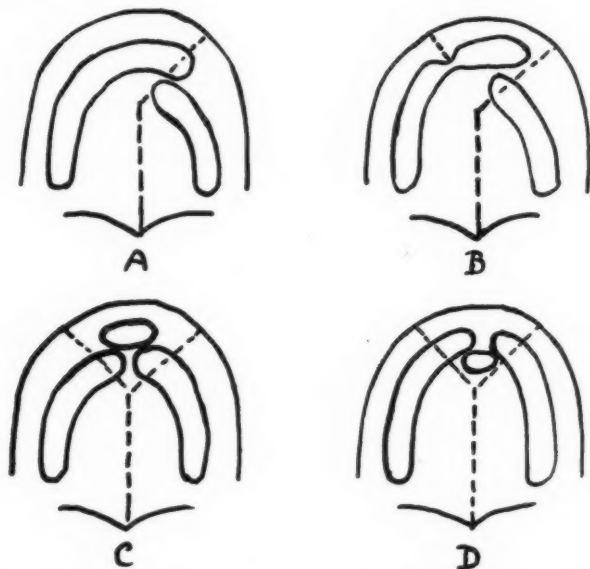
Fig. 2. Collapse of the maxillary segments in unilateral and bilateral clefts of lip alveolus and palate following surgical restoration of the circumoral musculature.

(a) and (b)   Unilateral cleft of left side, note collapse of lesser maxillary segment and its overlapping by the larger segments.

(c)   Bilateral collapse of both maxillary segments excluding the premaxillary segment from the arch.

(d)   The premaxillary segment is overlapped by the maxillary segments. When the premaxillary segment is wedged between the two maxillary segments little collapse of the arch can occur.

The research of Stark (1954) has confirmed the original work of Sir Arthur Keith (1941) that in all clefts there is a deficiency of tissue and that tissue is mesoderm ; it would also seem that there is a close connection between the degree of tissue deficiency and the severity of the cleft.

In unilateral and bilateral clefts we have the maxilla divided into two or three segments by the tissue deficiency, these segments are usually in a normal position until the lip is repaired but with the restoration of the circum-oral musculature the deficient arch is subjected to external pressure and collapses accordingly.   Under modern methods of treatment at Special Cleft Centres this maxillary collapse is not due to palatal surgery or scar tissue contraction but to the external pressure of the reunited facial muscles, acting on deficient maxillary arch.

Figure 2 shows the usual types of collapse we may expect to find in unilateral clefts of lip and palate, the greater segment usually overlapping the lesser segment.   In bilateral clefts the collapse is influenced by the direction of the external pressures and the surgical procedures employed.

The maxillary segments may collapse together excluding the premaxilla from the arch, or they may enclose the premaxilla which is palatally placed.

Figure 3 is of particular interest as it shows the degree of collapse which can occur in an unoperated Bilateral Cleft of lip and palate. This boy was fourteen years of age before he visited any centre and the position of the two lateral segments indicated that the causes of collapse are not fully understood.

Should the tissue deficiency be only slight and the contraction so timed that the segments meet end to end then little or no collapse occurs and very favourable maxillary shape results.

Orthodontic treatment may conveniently be divided into :

1. Dental orthopaedic treatment.

2. Orthodontic treatment.

Dental orthopaedic treatment aims at realigning the segments of the maxilla so that they are in normal relationship to the cranial base and the mandible.

In this way there is normal occlusion of the upper and lower teeth which promotes self cleansing and helps to eliminate caries.

The tongue is able to move freely in the restored upper arch assisting speech and deglutition.

The floor of the nose is increased in size assisting respiration and resonance.

The alar cartilages of the nose are repositioned and a general improvement to the facial contour is evident.

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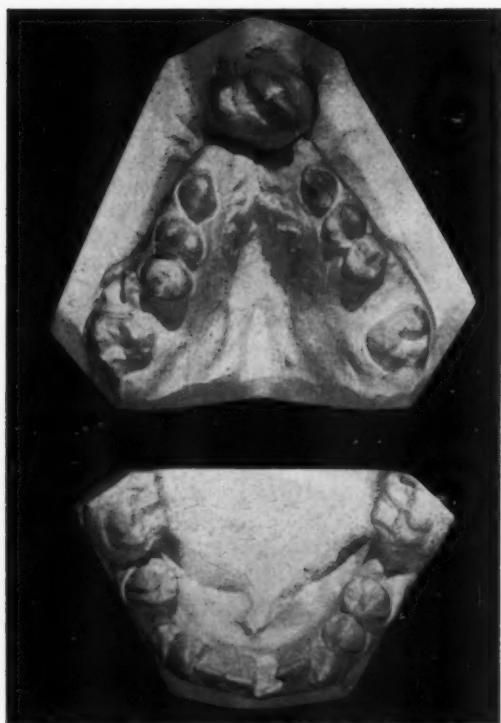
Fig. 3. Models of boy fourteen years. Bilateral cleft of lip and palate, completely untouched by surgery or orthodontics. Note collapse of lateral maxillary segments despite absence of lip or palatal surgery.

In addition the repositioned maxillary segments are now in normal relationship to the surrounding tissues and should attain the maximum growth, thus providing accommodation for the erupting permanent dentition.

Timing

Dental orthopaedics should be carried out as early as possible but should be delayed until full cooperation of the patient can be ensured. Four to six years is the ideal time and the younger the better but if the necessary cooperation is not forthcoming the treatment must be delayed until the mixed dentition.

The repositioning of the maxillary segments into normal relationship with the cranial base and mandible involves swinging the segments outwards against the contraction of the facial muscles, the fulcrum being

the cranio facial suture system of the maxilla. It is interesting to note that in most cleft cases the occlusion of the maxilla and mandible is normal in the first molar region.

Dental orthopaedic treatment should not be started until rapid success is ensured.

The active treatment should take three to six months and be followed by long periods of retention until the permanent dentition is established.

Appliances used vary very considerably and may include moveable appliances, multiband fixed appliances or silver cap splint appliances.

Figures 4 and 5 show common appliances used in maxillary alignment (Glass, 1958, 1959).

The double " C " spring moveable appliance is most useful in the deciduous dentition, its simplicity of construction and ease of adjustment are great assets, while the palatal bung to close any oro-nasal fistula is favoured by the speech therapists.

In adult dentition, movement of the maxillary segments is best achieved by silver cap splints with powerful palatal springs (Fig. 6).

Orthodontic treatment is carried out during the mixed dentition, the treatment is essentially tooth movement and the usual principles of
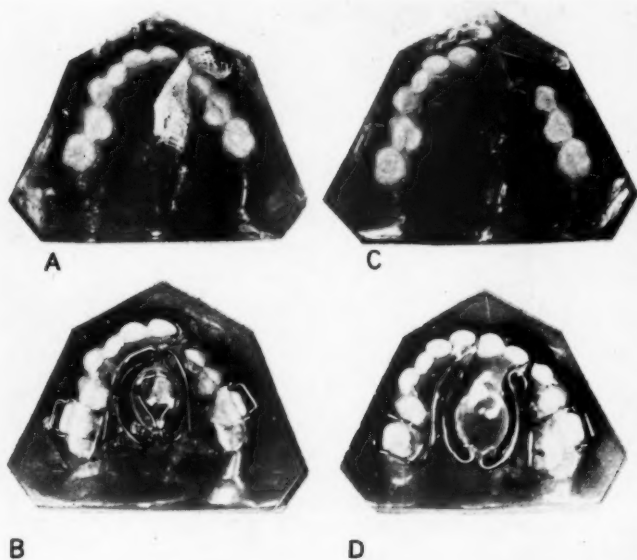
Fig. 4. Realignment of the maxillary arch in a unilateral cleft of lip, alveolus and palate using a " CC " Spring removeable appliance. Expansion of 1 cm. is achieved in two to three months.

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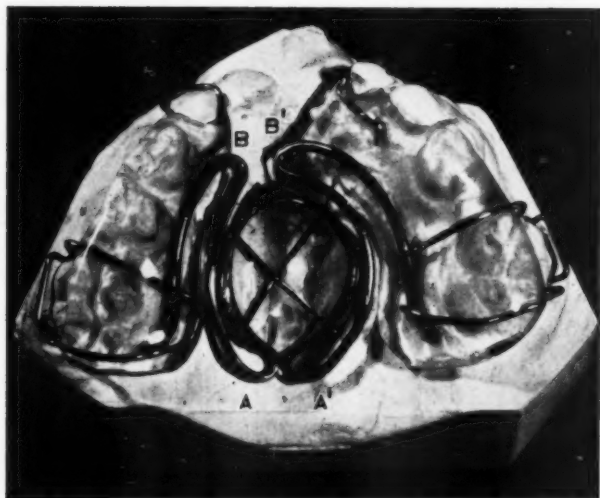
Fig. 5.   " CC " Spring expander with capping of all teeth and palatal bung to cover the palatal fistula.   The adjustments are made at points A, A¹, B, B¹.

Fig. 6.   Maxillary expansion in an adult (twenty-six years) by silver cap splints. Space is provided for the accommodation of the normal number of incisors and the facial contour is greatly improved.

everyday orthodontics apply.   The first and most important treatment is to establish an anterior overbite to give a stable incisor relationship and to support the labial segments.   This may be followed by a period of retention until the premolars and canines erupt after which further tooth alignment may be necessary.

The treatment is best carried out by a multiband fixed appliance, followed by retention.   The retention appliance will also carry any tooth

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or teeth to fill the space in the dental arch caused by the separation of the maxillary segments, and also the congenitally absent teeth in the region of the cleft (Fig. 7).
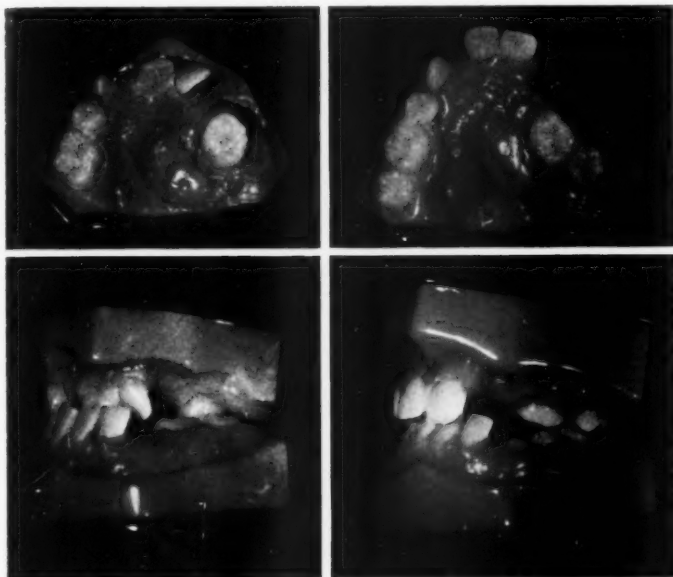
Fig. 7. Orthodontic treatment in the permanent dentition is by multiband fixed appliances. The correction of the anterior crossbite has been achieved and the increased size of the maxillary arch is evident.

CONCLUSION

With the completion of dental orthopaedic and orthodontic treatment the patient is again reviewed by the " cleft team " and any final nose and lip surgery is carried out. This is usually at about fifteen years of age. Following this the replacement of orthodontic retention appliances and missing teeth by carefully constructed prosthetic appliances completes the treatment programme.

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PROSTHETIC TREATMENT

by

K. P. Liddelow, F.D.S.R.C.S.

King's College Hospital Dental School

MORTON ROSEN DEFINES a cleft palate as " a fissure in the palate completely surrounded by a human being." I like this definition because it underlines the human side of the problem and for this reason I wish that prosthetics had no place in the treatment of cleft palate because it would be ideal if the plastic surgeon could heal the condition entirely with the individual's own tissues and the orthodontist correct any dental irregularities which supervene.

Unfortunately this millennium has not yet been reached and Sir Archibald McIndoe has already explained some of the reasons why surgery is not entirely successful ; it is in these cases and to those individuals who, for some reason or other, have never had any treatment that prosthetics has much to offer.

Such cases present, among others, two problems which are brought into focus by the questions which the patients ask when they attend for treatment : Can you improve my appearance and can you improve my speech ?

The restoration of appearance

The restoration of appearance may be a simple or a complex matter. Sometimes it is just a question of replacing a missing lateral incisor after successful surgery where the remaining teeth have been correctly positioned by orthodontic treatment. In these cases a simple denture frequently suffices and this can be remade from time to time to keep pace with the growth of the child. Frequently, however, to restore the appearance is a much more complex matter and especially is this so if considerable contraction of the dental arch has taken place following surgery. A typical case is illustrated in Figure 1a where it can be seen that the upper canines have been drawn inwards by contraction of the scar tissue in the palate and that the rest of the upper teeth have been lost from caries and
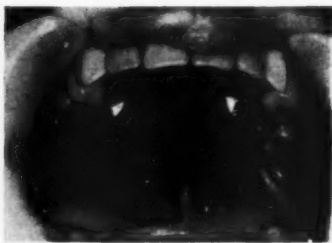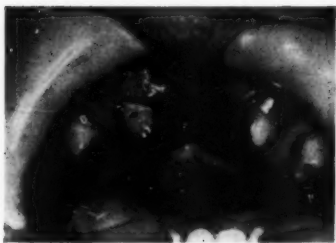
Fig. 1a. Contraction of the arch following surgery resulting in a mutilated appearance.

Fig. 1b. The appearance is improved by building the denture over the displaced natural teeth and setting the artificial teeth in a normal arch.

periodontal disease to which patients with cleft palates are particularly susceptible. The prosthetic treatment in this case was to fit a denture which covered the canines, setting the artificial anterior teeth in a much wider arch to support the lip and to occlude with the lower natural dentition which had not suffered any deformation (Fig. 1*b*).

Speech faults

The cleft palate speech deficiency is two-fold. The basic fault is that the patient is unable to close the oro-pharynx from the naso-pharynx and therefore the vibrating airstream proceeding from the larynx cannot be directed through the mouth to be modulated by the tongue, lips and teeth into articulate sounds, but escapes through the nose. The second fault is that, in an attempt to prevent this nasal escape, the patient bunches up the tongue into the pharynx making correct articulation impossible. The prosthetist's approach to this problem is to fit an obturator to enable the individual to close off the naso-pharynx from the oro-pharynx. This, however, will only cure the first fault. The cure of the second is in the hands of the speech therapist who must train the patient in correct articulation. This is a long, hard road and intelligible, pleasing speech will only be attained with perseverance and practice in those people who have good hearing and intelligence.

What is this obturator ? Is it a substitute palate ? Does it function as such ? Where is it placed ? How is it shaped ?

Taking these questions one by one : the work of Whillis, and Wardill (1930), Nohrström and Anderson (1959) and J. S. Calnan (1953), to mention but a few, have shown that the action of the normal palate in swallowing and speech is extremely complex and differs in both of these functions. It is therefore quite impossible to make an artificial appliance which can even approach the functions of the normal palate. Figure 2 is a
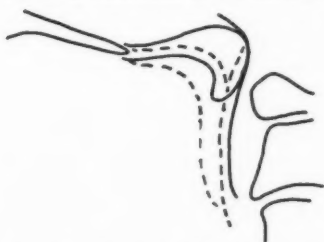
Fig. 2. Tracing from lateral radiographs showing position of soft palate when speaking (continuous line) and when swallowing (dotted line).

tracing from lateral radiographs of a normal individual showing the positions of the soft palate and the posterior pharyngeal wall when phonating the consonant " P " and when swallowing and it can be seen from this that the position of the palate and the pharynx differ markedly in both these functions. To construct an artificial appliance which would

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simulate the different movements of the palate in even these two positions caught by a momentary X-ray is quite impossible let alone all the infinitely fine variations of speech. An obturator, therefore, is simply a fixed pharyngeal extension to a denture.

The answer to the problem of how an obturator functions was perhaps first emphasized by John FitzGibbons (1931) who himself suffered from a cleft palate and wore an obturator. He drew attention to the fact that closure of the oro-pharyngeal isthmus is brought about by the lateral and posterior walls of the pharynx which learn to grip the obturator with a swallowing action both when speaking or swallowing.

The answer to the question " Where is the obturator placed " therefore follows from this that it should be placed in the plane of maximal contraction of the pharynx on swallowing. Where is this plane of maximal contraction and how does the pharynx function to produce it ? Figure 3a shows the relaxed pharynx of an individual with a cleft palate. Figure 3b
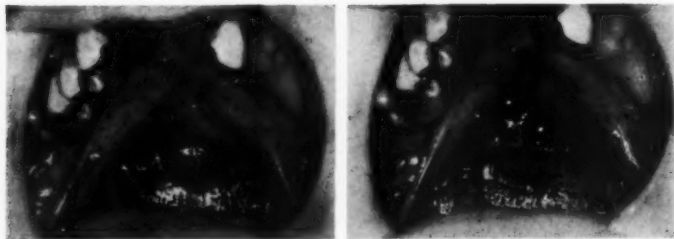
Fig. 3a. The relaxed pharynx of an individual with a soft palate cleft.
Fig. 3b. The pharynx of the individual shown in Fig. 3a contracted. Note the bulge of Passavant and the inward movement of the lateral walls.
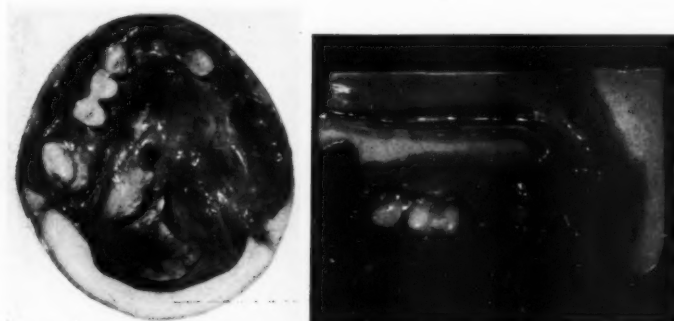
Fig. 4a. Model taken from an alginate impression showing contracted palato-pharyngeal sphincter mechanism of Whillis.
Fig. 4b. Saggital section of model shown in Fig. 4a. Note bulge of Passavant and bulge in lateral pharyngeal wall.

is o̤ the same pharynx contracted ; the bulge cf Passavant can clearly be seen on the posterior wall and it can be observed passing laterally to the bunched-up, contracted, lateral walls of the pharynx. Figure 4a is a model taken from an alginate impression of the same patient with the pharyngeal walls contracted and in this illustration the bulge of Passavant can clearly be seen producing a type of sphincter or ring mechanism. Figure 4b is a sagittal section of the same model showing the bulge of Passavant and the ring mechanism from the lateral aspect. Figure 5 is

Fig. 5. Position of palato-pharyngeal sphincter of Whillis. Note its coincidence with structures shown in preceding diagram.

a drawing of a dissection of the wall of the pharynx showing the palato-pharyngeal sphincter of Whillis which coincides identically with the position of the ring mechanism shown in the preceding diagrams. The position to place the obturator, therefore, is in the plane of the contraction of this ring mechanism and then the posterior and lateral walls of the pharynx will be able to contract around the obturator to seal off the naso-pharynx from the oro-pharynx and relax away from it in order to allow air to pass to and from the nose and the individual can learn to use his ring mechanism to produce the same fine variations of movement which the normal soft palate produces.

The answer to the question " How is the obturator shaped " depends on other anatomical factors and although the shape of any given obturator is peculiar to the individual certain basic types may be recognized and a knowledge of these may help when shaping an obturator. Figure 6 is a

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Fig. 6. Dissection in saggital plain showing levator muscle.
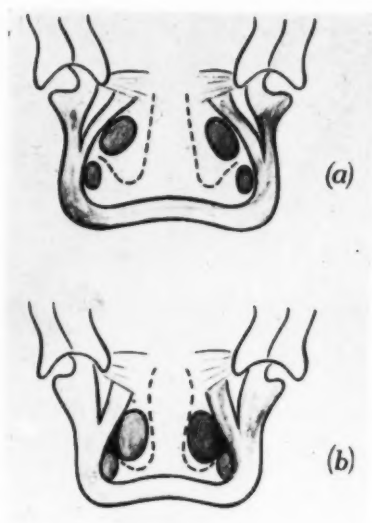
Fig. 7
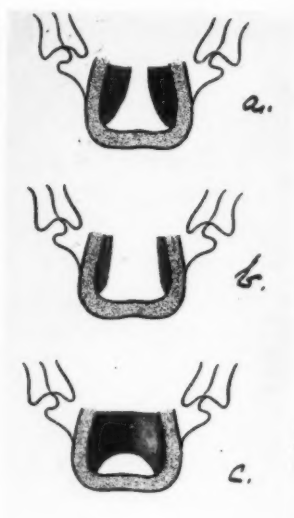
Fig. 8

dissection in the sagittal plane through the normal soft palate and pharynx. The levator muscle can be clearly seen and forming part of the lateral wall of the pharynx is the salpingo-pharyngeus muscle which is not visible in this dissection. Both these structures are within the grasp of the ring mechanism activated by Whillis's palato-pharyngeal sphincter and the shape of the obturator will depend to a considerable extent on the bulk and activity of these two muscles. A better idea of this can be obtained from observation of Figure 7. Figure 7a is a diagram, in the horizontal plane, of the palato-pharyngeal sphincter of Whillis embracing the levator-veli-palatini and the salpingo-pharyngeus muscles in the relaxed state. When these muscles and the sphincter of Whillis contract the shape of the pharynx and the cleft assume that shown in Figure 7b. The horizontal form of an obturator will therefore depend on the size and activity of the remnants of the levator muscles and on the activity of the salpingo-pharyngeus muscles and lateral walls of the pharynx. Figure 8 shows in diagrammatic form the three basic types of the horizontal form of obturator or speech bulb (compare with Figures 9a, 9b and 10).
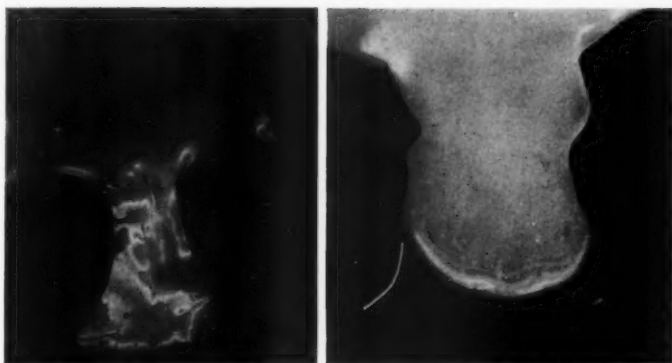
Fig. 9a. An obturator moulded by the muscles of an individual with well developed soft palate remnants.

Fig. 9b. An obturator moulded by the muscles of an individual with poorly developed soft palate remnants.

Figure 9a shows a bulb with definite evidence of levator muscle moulding in its " waist " area and it is T-shaped. A bulb of this general shape can be expected when well developed soft palate remnants are present.

Figure 9b shows the general shape of the bulb if the soft palate remnants are ill developed and the levator muscles are small or almost non-existent, or surgery resulting in scar tissue has rendered these muscles inactive. The bulb is not constricted in the " waist " area and assumes a rounded or pear-shaped form, being moulded almost entirely by the palato-pharyngeal sphincter.

Fig. 10.   An obturator for an individual with a repaired soft palate which is not fully functional.

Figure 10 illustrates the general form of the bulb when surgical repair of the palate has been performed resulting in a well united palate, but one which is too short to close the naso-pharyngeal isthmus. In these cases the bulb will approximate to the form of a flattened ellipse.

The lateral shape of the speech bulb

The bulb requires to be so shaped that it is gripped in its entirety by the palato-pharyngeal sphincter and its inferior surface should be slightly concave so as better to direct the airstream into the mouth.

The technique of trimming a speech bulb

The technique of trimming the bulb and its final shape will vary somewhat from patient to patient. Briefly, the technique which I favour is as follows :

A comprehensive impression of the dental, palatal and pharyngeal structures is taken in a special tray using alginate material and a denture constructed. If the cleft extends well forward into the hard palate, then a wire loop is processed into the denture extending backwards into the cleft of the soft palate to within three sixteenths of an inch of the posterior pharyngeal wall on a level with the tubercle of the atlas which can be easily identified from the model. The final adjustment of the plane of the wire loop is made in the mouth. If the case is one in which surgery has been performed and an area of united soft palate separates the back edge of the denture from the remaining cleft then dilute a piece of wax on to the back edge of the denture and, placing the denture in the mouth, allow the wax to record the relaxed position of the soft palate. A model is then cast to the denture, the wax removed and replaced with a thin layer of cold cure resin which provides a correctly angulated and firm tailpiece to the denture, lying in intimate contact with the inferior surface of the

relaxed soft palate. (This is later replaced with a metal or heat cured tailpiece to which the final obturator is processed.) The trimming of the speech bulb is now possible in both types of case and this is done with black gutta percha. The gutta percha is heated in boiling water for several minutes and then moulded on to the wire loop or the end of the tailpiece. The denture is now inserted and the gutta percha gently pressed into the area of the cleft. Trimming the bulb takes time and patience on both the patient and operator's parts. It is perhaps best instituted by asking the patient to lower his chin on to his chest (this brings the posterior pharyngeal wall forward), and then to turn his head from side to side followed by a few sips from a cup of hot tea. The denture is then removed and the gutta percha observed. Certain definite landmarks made by the various structures of the pharynx already mentioned should be looked for, and the bulb trimmed or added to, depending on whether it is oversize or deficient, and then it is replaced and the patient asked to say words which contain sounds which cause active movement of the walls of the pharynx, such as " car," " gar," " par," followed by more tea and head movements. The bulb is constantly removed and trimmed and adjusted until an adequate and comfortable shape is arrived at. The patient is then dismissed and wears the bulb for twenty-four to forty-eight hours. At the next visit further trimming and adjustment is made and finally some zinc oxide, starch and lanolin paste is applied to the bulb and the final trimming by function is done. This paste ensures that even the most delicate structures are not over-extended because the gentlest pressure will impress the paste. The bulb is then processed in acrylic resin and the patient wears it and the final adjustments are made as required in co-operation with the speech therapist who trains the patient to develop the correct technique of gripping the bulb and in the correct methods of articulation.

ACKNOWLEDGMENTS

My grateful thanks are due to Professor R. Cocker who took many of the colour transparencies which illustrate this symposium ; to Mr. Smith of King's College Hospital Photographic Department for making black and white prints ; to Professor T. Nicol of King's College for preparing and photographing the illustrations in Figure 6 ; to Mr. R. Gain for much helpful advice and the loan of some slides and to Mr. A. P. Gimson for allowing me to photograph and record the speech of one of his patients.

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FORMAL OPENING
OF THE L. D. S. CENTENARY CELEBRATIONS
at the Royal College of Surgeons of England on 23rd July 1959

ADDRESS
by
The Dean of the Faculty of Dental Surgery
Sir Wilfred Fish, C.B.E., D.Sc., F.D.S.R.C.S.Eng.

" We have met this morning to inaugurate the real business of this Centenary Celebration ; by that I mean the scientific and historical survey of the hundred years that have elapsed since the Council of the College received the famous Royal Charter ; the Charter, that is, by which they were empowered to institute a diploma in dental surgery.

" Unfortunately, at this busy season of the year, it is impossible to secure several days together when everyone is free ; and we are particularly unfortunate this morning in that the President himself is unable to be with us. He left for Scotland immediately after the reception last night, but I am glad to say that he will be back in time for to-morrow's meeting. Moreover the Vice-President is here and in a few moments will give us a message from Sir James. Perhaps, however, I may say that we would all like to congratulate the President on the reason for his absence. It is that this afternoon he is to be admitted to the Honorary Fellowship of our sister college in Edinburgh.

" In looking back over the century that has gone it is not easy to make a just assessment of those early events that happened a hundred years or so ago ; viewed down the long corridor of time they lose their context, the people themselves become shadows and their motives, if not their intentions, seem obscure. We are, however, fortunate in having a detailed and well documented contemporary account of those hard and often contentious decisions that determined what kind of profession we should inherit. We have no reason to regret the steps that were taken. No one can say that any other course of action would have produced a more satisfactory result. Perhaps that is because even in those early days all parties were agreed that the young practitioner must be given a better training, and that there must be a greater diffusion of knowledge amongst those who were already in practice.

" In the years that have passed since then there have been other milestones that have marked our progress. The founding of dental schools was an immediate response to the Charter ; two were established before even the first diploma could be awarded. Registration followed twenty years later, and a professional Association was formed about the same time ; then after a further lapse of forty years came the Dental Board and now an autonomous General Dental Council ; meanwhile this Faculty was founded.

" It is with this evolution and with the scientific advances that have marched in step with these administrative developments that we are concerned today."

ADDRESS
by
Dr. W. G. Senior, C.B.E., F.D.S.R.C.S.Eng.,
President of the Section of Odontology of the Royal Society of Medicine

" IT WOULD I know be the earnest wish of the Council and the Section of Odontology of the Royal Society of Medicine that I should first express the deep sense of gratification we all feel that we should have been invited to participate in this opening ceremony of the Centenary Celebrations.

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" My colleagues and I regard the invitation as the outward and visible sign of that close bond which has always existed between the College and ourselves. We remember that it was mainly due to the persistent efforts of those stalwart members of the Odontological Society, from which body we are directly descended, that the College moved for the Charter.

" Happily, I am not called upon to recount the fascinating history of those early negotiations—the false starts, the frustrations, and then success. That task has been discharged far more ably than I could ever hope to achieve. I betray no secret when I tell you that the Dean has in the press an extremely interesting—and most scholarly—account of that time which represents the result of many months of research. But for the printing difficulties this would have appeared in the *British Dental Journal* and I will not anticipate your pleasure.

" If I may refer very briefly to the link between our two bodies I would remind you of the account given recently by Professor Miles, the Honorary Curator of the Odontological Museum, on the occasion of the annual meeting of the Section held by custom in this College. Professor Miles demonstrated specimens a century old which stood side by side with the appropriate volumes of the transactions of the Odontological Society in which they were described. That is our precious link. Through the century the Odontological Society met in various homes and the collection was developed by a succession of honorary curators until it passed into the care of the College in 1909 under Sir Frank Colyer, who may be said to have made it his life's work. In 1947 it was handed over to the custody of the College, fittingly housed in its new home and in the equally affectionate care of Professor Miles, who will shortly tell you more of its history. In 1906 the Odontological Society became one of the founder bodies which coalesced to form the Royal Society of Medicine, and as the Section of Odontology we are proud to continue the traditions of our forbears.

" May I, Sir, through you offer our sincere congratulations to the College and to its Faculty of Dental Surgery on the attainment of the first hundred years in the history of the Licence of Dental Surgery in this country, and may I also congratulate you and your organizing committee on the excellence of the arrangements which you have made."

HISTORICAL SUMMARY
by
Professor A. E. W. Miles, L.R.C.P., M.R.C.S., F.D.S.R.C.S.Eng.
Honorary Curator of the Odontological Collection

" This year 1959 marks two extremely important events in the life of the Odontological Museum of the Royal College of Surgeons.

" First, the Collection celebrated its Centenary year in July and secondly the move from various stores and packing cases into a new and fitting home is gradually taking place.

" During the earlier life of the Museum it settled in the various homes which were associated with the parent Odontological Society. It is noted that, in the early days of its existence, the Society had kept some specimens, although the first record of the presentation of a specimen is on 2nd April, 1859, when Mr. Finnie of Egypt sent a hippopotamus skull. This gift arrived a few months before the formation of a museum room with a library attached and records show that in June, 1859, for the additional sum of £10, the Society was granted the lease of a room on the second floor of the new Dental Hospital at 32, Soho Square " for the purpose of a Museum and Library, such rent to include the opening of the front door by the Hospital Porter.

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" Early the following year Edwin Sercombe was appointed Curator only to resign a few months later and was immediately succeeded by W. F. Forsyth. This gentleman was still in charge when in 1863 the large and important collection of the rival College of Dentists was absorbed on the amalgamation with the Odontological Society.

" There followed a succession of curators and the next important step forward was the preparation of the first catalogue compiled by C. S. Tomes in 1872.

" Some two years later in 1874 the London School of Dental Surgery decided to move to a site in Leicester Square. The Odontological Society and its Museum and Library followed and occupied quarters in the new hospital building until 1900. It then moved to 20, Hanover Square following a brief period of storage in packing cases at the Royal College of Surgeons. However, in 1907 the amalgamation of the various medical societies took place and the Odontological Society became the Odontological Section of the Royal Society of Medicine.

" This meant that the Museum specimens had to be found alternative accommodation and the custody was handed over by deed of transfer to the care of the Royal College of Surgeons and consisted of some 5,000 specimens under the care of the Curator, Sir Frank Colyer.

" It was housed in a large semi-basement room, which, as many will remember, was reached by a staircase behind Hunter's statue at the far end of the old Room II of the Royal College of Surgeons Museum.

" On the outbreak of war in 1939, steps were taken to preserve and protect the Collection and although in 1941 the College and its museums were severely damaged, by good fortune the Odontological series escaped more or less unscathed.

" In 1943, the Council of the Royal Society of Medicine offered as a goodwill gesture the original Odontological Collection towards the restitution of the grievously damaged museums of the Royal College of Surgeons. This offer was gratefully accepted and the Royal Society of Medicine still retains its traditional connections, however, by the annual meeting of the College and the right to be consulted regarding the appointment of the Honorary Curator.

" In 1950, the Collection was once again packed into boxes and cases and moved out of rooms it had occupied for forty-one years. Since that time the future of the collection has given cause for much anxiety until recently when during this past year the move into the new and fitting quarters commenced.

" For more than one-half of the life the museum has been in existence, it was in charge of one Curator, namely Sir Frank Colyer. His purpose was to make the museum into much more than a shop window of specimens and to gather together a collection of material which by careful study could be used for the advancement of knowledge.

" This great museum which has been built up over the years is probably unequalled anywhere in the world and must be preserved for all time and extended in accord with modern requirements."

ADDRESS
by
Miss Jessie Dobson, B.A., M.Sc., A.C.I.S.
Anatomy Curator, Royal College of Surgeons of England

" When the museum of the Odontological Section of the Royal Society of Medicine was handed over to the College by deed of trust fifty years ago it consisted of some 5,000 specimens. The College collections had then reached the prodigious total of 70,000 items, embodying John Hunter's original 13,000 and the numerous additions that had been made during the previous century. This vast accumulation was housed in five large rooms, each with two galleries,

and several side rooms. A room beneath the existing Room II was specially prepared for the new acquisition which was thought to be an interesting but not very significant section of the museums, representing numerically a mere fifteenth and in bulk an even smaller proportion of the whole. In 1941, as a result of enemy action, severe damage was sustained both to the museum rooms and to their contents and only about 20,000 specimens were left. The Odontological Section, however, remained intact so that now it represents about one-fifth of the total collection, a ratio more nearly allied to its relative value.

" In 1909 the Conservator of the museum was Sir Arthur Keith and he and Sir Frank Colyer, the Honorary Curator of the Odontological Section, agreed that it would be appropriate if all those specimens prepared by John Hunter to illustrate the growth, use and diseases of the teeth should be included in this new section. This group of specimens was of particular interest. Hunter's original collection consisted of three main series—normal human and comparative anatomy, pathology and osteology—and each of these contained preparations relating to the teeth and jaws. Some of them had been prepared as early as 1755 and it was upon these that he based the observations and conclusions that he put forward in his first book, published in 1771, with the title of *The Natural History of the Human Teeth*. This was the only work that he sold to a bookseller and it is said that he did this in order to pay for the expenses of his wedding which took place on July 22nd of that year. Unfortunately we have no information about the financial details of the transaction so that we do not know whether the outlay for the ceremony was on a lavish scale or not ; in other words, whether the bookseller felt that he was taking a chance or had recognised a best seller. A second edition, together with the second part, appeared in 1778 and a third edition of both parts was issued in 1803. The illustrations for the work were prepared by Jan van Rymsdyk, a native of Holland and a fine artist, who came to live in this country in 1760. These original drawings are preserved in the Library of the College.

"As it seemed more than likely that those attending these Centenary Celebrations would be interested to see this historic group of specimens, they have been put on display in the first bay of the Wellcome Museum on the third floor of the College. Here also can be seen Hunter's own catalogue of his museum, opened at the appropriate pages, as well as the original manuscript of the first part of *The Natural History of the Human Teeth*, the 1803 edition of the complete work and some photographs of the original drawings. It cannot often happen that it is possible to put on show such a complete record of the stages of preparation of a scientific publication."

ELECTION OF DEAN AND VICE-DEAN OF THE BOARD OF FACULTY OF DENTAL SURGERY

At a Meeting of the Board of Faculty on 25th July 1959 Professor Martin A. Rushton, of Guy's Hospital, was elected Dean of the Faculty for the ensuing year in succession to Sir Wilfred Fish, C.B.E. Brigadier R. A. Broderick, D.S.O., M.C., T.D., was elected Vice-Dean in succession to Professor T. Talmage Read.

Sir Wilfred Fish, C.B.E., the immediate past Dean of the Faculty of Dental Surgery has presented to the Faculty a fine silver cup, dated 1751, to commemorate the L.D.S. Centenary Celebrations over which he presided as Dean.

SPEECH BY THE PRESIDENT OF THE COLLEGE
(PROFESSOR SIR JAMES PATERSON ROSS)
AT THE ANNUAL MEETING OF THE FACULTY
Friday, 24th July 1959

" Mr. Dean, My Lord, Ladies and Gentlemen :

" I would like first of all, Mr. Dean, to express to you and your Faculty on behalf of the Council of the College, our congratulations on this very important occasion, the centenary of the establishment of the Licence in Dental Surgery. You may feel that it is late in the day for me to say this, because your celebrations started on Wednesday. But I was not here to say it yesterday because as you know I was otherwise occupied, and I hope you will accept this as a genuine message of congratulation from the College.

" This is, of course, an important day of celebration for the Faculty and for all Licentiates in Dental Surgery of the College. But it is also an important day for the College itself, and I am very happy to think of the way in which we live together—the Faculty and the College—and that we share any honours that come to either of us with equal enthusiasm and enjoyment. I can assure you that the College as a whole rejoices with you on this important and happy occasion.

" I am not going to speak for very long because most of you must be well aware of the important changes which have been taking place in the College within the past fourteen or fifteen years—really since the time at which we began to repair the damage of war. But you will all be aware that these changes mean much more than just the rebuilding of the College. I think you all realize that there is a significant change in the spirit and life of the College—in its aims and objects —and one of the most important elements in that change is the development of Faculties within the College, which are almost in a way separate entities, for they govern themselves, yet are subject to the Council of the College. This is a very harmonious symbiosis, and we in the College are very proud of the Faculties, and I know that the Dental Faculty is proud of its relationship to the College.

" We would like to congratulate the Faculty on the way it has progressed during the course of the last ten years. You have established your own Fellowship. But particularly you are establishing standards of education and of research within this College, and many of you were present recently when Lord Cohen opened formally the Department of Dental Science and that seemed to us a very important milestone in the history of the Faculty and the College. We have much to be thankful for, and much to congratulate ourselves upon in the last ten years, and, as I say, the work has been of great value not only to the dental profession but to the College as a whole.

"And now in conformity with the principle on which we work, whereby the Council is accustomed to delegate to the Faculties matters which principally concern themselves, I am going to hand over to the Dean of the Faculty the conduct of the rest of this meeting."

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L.D.S. CENTENARY CELEBRATIONS
22nd-24th July

THE CELEBRATION OF the centenary of the Charter of 1859 which instituted the Licence in Dental Surgery was perhaps above all the celebration by the dental profession of a century of life with the surgeons; and one of the most pleasing aspects of those three crowded days was the underlying feeling that both partners in this long marriage had somehow preserved, and indeed augmented, their feelings of respect for each other. There can have been few Fellows or Licentiates in Dental Surgery who did not experience a feeling of pride at the honoured place which their Faculty had achieved for itself in the very active College of the mid-twentieth century; and dentists from all over the world observed with some awe how much at home the Faculty appeared to be amidst all the ceremonial and panoply of the College (Fig. 1). At the same time their surgical colleagues must have responded with warmth to the words of the President when he emphasised the common interests of Faculty and College, and their common joy when either had cause for celebration.

Fig. 1. The Dean of the Faculty, Sir Wilfred Fish, C.B.E., and Lady Fish receiving Dr. and Mrs. bin Mohamad Salleh of Malaya at the Reception in the College.

This is not to say that the problems and disagreements of 1859 had been forgotten. As in all family gatherings there lay not far beneath the surface the hint of unresolved conflicts of will and interest. But at

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least for the moment the dominant message from the Faculty appeared
to be not

> " Her nis no hoom, her nis but wildenesse ;
> Forth, pilgrim, forth ! "

but rather

> " Daughter am I in my mother's house
> But mistress in my own.
> The gates are mine to open
> As the gates are mine to close.
> And I abide by my Mother's Home."

There were reminders of this satisfaction, and this recognition of the
debt to the College throughout the three days' programme. At the formal
opening, there was celebrated the centenary of the Odontological Collec-
tion, now so finely housed in the College, next to the Department of
Dental Science and opposite the site of the new Hunterian Museum, the
nucleus and emotional centre of the College. At the symposium the choice
of subject itself and the presence on the panel of a surgeon and a basic
scientist as well as two dental surgeons indicated the closeness of
dentistry's alliance to medicine. Not least at the annual meeting was this
alliance exemplified in the tribute paid to a distinguished surgeon, an
eimnent physician and an outstanding university administrator by their
election to the Honorary Fellowship in the Faculty (Fig. 2).

The dental schools in England had not been slow to seize the opportunity
of demonstrating how well this debt to medicine had been repaid by the
dental profession over the years. In a series of scientific exhibits which were
a delight to the eye and a stimulus to the imagination, they showed what
these past hundred years had brought in the way of progress and fulfilment.
These demonstrations and the historical exhibit formed an admirable
background against which the events of the Centenary took place (Fig. 3).
The details of the historical setting were filled in by Professor Robert
Bradlaw in his Menzies Campbell Lecture, and it was a happy chance that
enabled the first of these lectures to be delivered during the Centenary
Celebrations and in the presence of Dr. Menzies Campbell himself.

From universities and dental associations throughout the world repre-
sentatives came bringing with them messages of good will and congratula-
tion (Fig. 4). They came from as far afield as Australia, India, Malaya,
Canada and the United States of America. Some brought gifts, and
among these was a fine Delft plate portraying the façade of the College
in 1859, presented by Dr. Charles Nord on behalf of the Dutch dental
profession. It had fallen to him to speak at the Annual Meeting on
behalf of all who had brought congratulatory messages.

Many of the congratulatory addresses were objects of great beauty and
all bore messages which will long be treasured by the College and the

Fig. 2. Recipients of awards and others at the Annual Meeting of Fellows and Licentiates in Dental Surgery.

From right to left : Sir Cecil Wakeley, Bt., Sir Douglas Logan and the Rt. Hon. Lord Cohen, Honorary Fellows in the Faculty of Dental Surgery : Dr. H. St. John Atkins, President of the National University of Ireland : Mr. W. E. Earle and Dr. Don Gullett, Elected Fellows in Dental Surgery.

Fig. 3. One of the scientific exhibits arranged by the Dental Schools.

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Faculty. A list of those bodies who presented them is printed on page 265. Worthy perhaps of special mention was that from the University of Birmingham, the elegant Latinity of which was equal even to the rendering of " iced lollies " (*lollia gelida*).

Fig. 4. Dr. W. G. Senior, C.B.E., presenting a congratulatory address to the President on behalf of the Section of Odontology of the Royal Society of Medicine.

The delegates and their ladies were entertained by the Faculty at the Festival Dinner, in the presence of the Lord President of the Council, the Mayor and Mayoress of Westminster, the Lord Mayor of London, the High Commissioners for Australia and South Africa, the Lord Bishop of London, the Minister of Health and other distinguished guests. Lord Hailsham, in proposing the toast of the Faculty was unable to forgo a passing reference to the merits of Conservative dentistry but preserved an appearance of political impartiality by promising liberal support for more radical research. The Dean, in an eloquent reply, reminded the Lord President of the College's traditional preoccupation with research—a tradition which was being carried on by the Faculty in its own new department. Professor Rushton welcomed the guests with urbanity and erudition and Sir Douglas Logan, the Principal of the University of London and a newly-elected Honorary Fellow in the Faculty, replying on their behalf, took the opportunity of enunciating a new law, " Logan's Law for After-Dinner Speakers," to the effect that the length of an after-dinner speech should vary in inverse proportion to the excellence of the hospitality provided. The brevity of his speech, and of those of the other speakers, was taken as a gracious compliment to the success of the occasion.

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The University of London again participated in the celebrations when, as the last event in the programme, the Vice-Chancellor entertained over five hundred guests at a reception in the Senate House. In the neo-Cretan magnificence of its ceremonial rooms, the guests wandered for a while in climactic reverence before returning once more to their daily tasks and to the second hundred years.

Fig. 5. The historical exhibit, depicting a surgery of the mid-nineteenth Century.

In the old Council Room of the College the wax model of John Tomes presided still over the Victorian surgery so skilfully reconstructed by the historical sub-committee (Fig. 5) ; and on his bearded countenance there seemed to linger a smile of satisfaction.

R. S. J.-G.

EVELYN SPRAWSON PRIZE

PART OF THE income from the bequest of £5,000 left to the College by the late Evelyn Sprawson, F.D.S.R.C.S., for the advancement of dental science is to be devoted to the provision of a prize. This prize will be awarded to the candidate in Part II of each Final L.D.S. Examination who obtains the highest marks, who is sitting the examination for the first time, and who reaches a standard which is, in the opinion of the examiners, sufficiently high to merit the award.

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L.D.S. CENTENARY CELEBRATIONS: CONGRATULATORY ADDRESSES

THE FOLLOWING UNIVERSITIES and dental associations presented addresses of congratulations to the College and Faculty on the occasion of the L.D.S. Centenary:

Universities in United Kingdom:

Belfast	Glasgow
Birmingham	Leeds
Bristol	Liverpool
Cork	Manchester
Durham	Sheffield
Edinburgh	St. Andrews

Universities in the Commonwealth:

Sydney	McGill
Alberta	Toronto

University outside the Commonwealth:

Columbia

Dental Associations in United Kingdom:

American Dental Society of Europe
American Dental Society of London
British Dental Association
British Society of Periodontology
British Society for the Study of Orthodontics
British Society for the Study of Prosthetic Dentistry
Section of Odontology of the Royal Society of Medicine

Dental Associations throughout the World:

American Dental Association
Australian Dental Association
Canadian Dental Association
Belgium : Association Generale des Dentistes de Belgique and Association des Licencies et Dentistes Universitaires de Belgique
France : French Dental Association
India : All India Dental Association
Malayan Dental Association
New Zealand Dental Association
Sweden : Swedish National Committee for the Federation Dentaire Internationale

Other Bodies:

International Dental Federation

The Faculty also received the following gifts :

From Dr. C. F. L. Nord, on behalf of the Dutch Dental Profession— A Delft plate depicting the College in 1859.

From Dr. Sigurd Vik, on behalf of the Norwegian Dental Association —A silver and enamel bowl.

From Dr. Erich Müller, on behalf of the German Dental Association —An etching of Cologne by Professor Luigi Kasimir.

PROCEEDINGS OF THE COUNCIL IN OCTOBER

AT A MEETING of the Council on 8th October 1959, with Professor Sir James Paterson Ross, President, in the Chair, Professor M. A. Rushton was admitted to the Council as a co-opted member representing Dental Surgery.

Professor R. S. Pilcher was admitted to the Court of Examiners.

The Handcock Prize was presented to Dr. E. W. L. Fletcher of St. Thomas's Hospital Medical School.

Peter Beck, of Wyggeston Boys' School, Leicester, and St. Mary's Hospital Medical School, was admitted as the twenty-eighth Macloghlin Scholar.

Three Diplomas of Membership, one Diploma of Fellowship and two Licences in Dental Surgery were granted.

Diplomas of Fellowship in the Faculty of Anaesthetists were granted to thirty-three candidates.

The following diplomas were granted, jointly with the Royal College of Physicians : *Ophthalmology* (36), *Physical Medicine* (4), *Tropical Medicine and Hygiene* (42).

The sixty-second Jenks Scholarship was awarded to G. A. C. Welply, formerly of Epsom College and now at King's College Hospital Medical School.

The following hospitals were recognised under paragraph 23 of the Fellowship Regulations :

HOSPITALS	POSTS RECOGNIZED		
	General (6mths. unless otherwise stated)	Casualty (all 6mths.)	Unspecified (all 6mths.)
BARNET—General Hospital (Additional)		3 S.H.O.s (Cas. & Orth.) *instead of* H.S. (Orth.) (unspecified) *and* Cas. Off.	
LONDON — London Chest Hospital (Arlesey Branch)			S.H.O.
N. IRELAND—Waveney Hospital, Ballymena	Sen. Regr. Regr.		
LONDON — Royal Northern Hospital, Holloway (Additional)			*Under para. 23(c)* Regr.
LEEDS—St. James's Hospital (Additional)			H.S. (G.U.)
BIRMINGHAM — Dudley Road Hospital (Additional)	Regr. (12m.)		
LONDON — Prince of Wales's General Hospital, Tottenham. (Redesignation)		*Redesignation of* Cas. Off. (S.H.O.) *as* Cas. Regr.	
ENFIELD—Chase Farm Hospital (Redesignation)	*Redesignation of* Pre-Reg. H.S. *as* S.H.O.		
DARTFORD—Southern Hospital ..	Transfer of recognitio n to Joyce Green Hosp ital, Dartford.		
ARMY—British Military Hospital, Kowloon, Hongkong.	Transfer of recognitio n to British Military H ospital, Bowen Road.		
NEW ZEALAND — Southland Hospital, Invercargill	3 Regrs.		

FORTHCOMING LECTURES AND DEMONSTRATIONS
FOR 1959-60

WEDNESDAY, 4th November, at 5 p.m.

UROLOGY LECTURE
by William S. Mack.

THURSDAY, 5th November, at 5 p.m.
" Vagal nerve section in chronic duodenal ulceration."

HUNTERIAN LECTURE
by Prof. H. W. Burge.

THURSDAY, 12th November, at 5 p.m.
" Surgery of the biliary passages."

BRADSHAW LECTURE
by Mr. A. Dickson Wright.

TUESDAY, 17th November, at 5 p.m.
" Recent advances in the surgery of typhoid fever."

HUNTERIAN LECTURE
by Prof. R. L. Huckstep.

THURSDAY, 19th November, at 5 p.m.
" New additions to the museum."

ERASMUS WILSON DEMONSTRATION
by Dr. L. W. Proger.

THURSDAY, 26th November, at 5 p.m.
" Some anatomical and pathological considerations concerning multiple hydatid cysts in the chest."

ARRIS AND GALE LECTURE
by Mr. Norman R. Barrett.

THURSDAY, 3rd December, at 5 p.m.

ERASMUS WILSON DEMONSTRATION
by Dr. H. G. H. Richards.

THURSDAY, 3rd December, at 5.30 p.m.

OTOLARYNGOLOGY LECTURE
by Mr. Norman R. Barrett.

TUESDAY, 8th December, at 4 p.m.
" Hormone dependent cancer: the present position."

IMPERIAL CANCER RESEARCH FUND LECTURE
by Dr. E. F. Scowen.

WEDNESDAY, 9th December, at 2.30 p.m.

WATSON-JONES LECTURE
by Lord Cohen of Birkenhead.

THURSDAY, 10th December, at 5 p.m.
"An experimental study of propulsion in isolated loops of intestine, and application of the findings in the surgery of neonatal intestinal obstruction."

HUNTERIAN LECTURE
by Prof. H. H. Nixon.

THURSDAY, 17th December, at 5 p.m.
" The cellular anatomy of experimental wound healing."

ARRIS AND GALE LECTURE
by Dr. R. M. H. McMinn.

THURSDAY, 14th January, at 5 p.m.

ROBERT JONES LECTURE
by Sir Walter Mercer.

WEDNESDAY, 27th January, at 5 p.m.

ARNOTT DEMONSTRATION
by Dr. D. H. Tompsett.

THURSDAY, 28th January, at 5 p.m.
" Missile injuries in Cyprus."

HUNTERIAN LECTURE
by Lieut. Col. J. C. Watts.

TUESDAY, 2nd February, at 5 p.m.
" Fractures of the neck of the femur in children."

HUNTERIAN LECTURE
by Prof. A. H. C. Ratliff.

THURSDAY, 4th February, at 5.30 p.m.

OTOLARYNGOLOGY LECTURE
by Prof. T. Pomfret Kilner.

THURSDAY, 11th February, at 5 p.m.

MOYNIHAN LECTURE
by Dr. Bradley L. Coley.

TUESDAY, 16th February, at 5 p.m.

OPHTHALMOLOGY LECTURE
by Prof. A. Sorsby.

THURSDAY, 18th February, at 5 p.m.

ERASMUS WILSON DEMONSTRATION
by Dr. M. O. Skelton.

THURSDAY, 3rd March, at 5.30 p.m.

OTOLARYNGOLOGY LECTURE
by Dr. R. M. B. MacKenna.

THURSDAY, 10th March, at 5 p.m.
" Diffuse ulcerative colitis and its treatment by ileorectal anastomosis."

HUNTERIAN LECTURE
by Prof. S. O. Aylett.

WEDNESDAY, 16th March, at 4 p.m.

JOSEPH CLOVER LECTURE
by Dr. J. A. Lee.

THURSDAY, 17th March, at 5 p.m.
" Supervoltage X-ray therapy of intracranial tumours."

HUNTERIAN LECTURE
by Prof. Arthur E. Jones.

TUESDAY, 22nd March, at 5 p.m.
" Endocrine and metabolic aspects of peripheral blood vasoplastic disease."

ARRIS AND GALE LECTURE
by Mr. J. H. Peacock.

WEDNESDAY, 23rd March, at 5 p.m.
" Cancer of the mouth."

HUNTERIAN LECTURE
by Prof. Howard H. Eddey.

THURSDAY, 24th March, at 5 p.m.

ERASMUS WILSON DEMONSTRATION
by Dr. A. G. Stansfeld.

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MONDAY, 28th March, at 5 p.m.

EDRIDGE-GREEN LECTURE
by Dr. R. A. Weale.

TUESDAY, 29th March, at 5 p.m.
" The surgical treatment of mandibular progna-
thism with special reference to functional
anatomical considerations in diagnosis and
treatment planning."

HUNTERIAN LECTURE
by Prof. J. H. Hovell.

THURSDAY, 31st March, at 5.30 p.m.

OTOLARYNGOLOGY LECTURE
by Mr. D. W. C. Northfield.

TUESDAY, 5th April, at 5 p.m.

OPHTHALMOLOGY LECTURE
by Prof. A. Sorsby.

THURSDAY, 7th April, at 5 p.m.
" Natural history of arteriosclerosis of the lower
extremity."

HUNTERIAN LECTURE
by Prof. K. Bloor.

THURSDAY, 14th April, at 5 p.m.
"Arm prosthesis and appliances, their functional
value in industry."

JOSEPH HENRY LECTURE
by Mr. Leon Gillis.

THURSDAY, 21st April, at 4.15 p.m.

ARNOTT DEMONSTRATION
by Dr. B. D. Wyke.

WEDNESDAY, 27th April, at 5 p.m.

ARNOTT DEMONSTRATION
by Dr. A. A. Barton.

THURSDAY, 28th April, at 5 p.m.
"Arterial embolism in the lower limbs."

HUNTERIAN LECTURE
by Prof. W. J. Metcalfe.

TUESDAY, 3rd May, at 5 p.m.

ERASMUS WILSON DEMONSTRATION
by Dr. J. R. B. Williams.

THURSDAY, 5th May, at 5.30 p.m.

OTOLARYNGOLOGY LECTURE
by Sir Victor Negus.

THURSDAY, 12th May, at 5 p.m.
" Technique and late results of Porto-Azygos
disconnexion for oesophogeal varices."

HUNTERIAN LECTURE
by Prof. Norman C. Tanner.

WEDNESDAY, 22nd June, at 5 p.m.

ARNOTT DEMONSTRATION
by Miss J. Dobson.

WEDNESDAY, 13th July, at 3.30 p.m.

BERNHARD BARON LECTURE
by Prof. D. Slome

FRIDAY, 15th July

CHARLES TOMES LECTURE

ANATOMICAL MUSEUM

THE SPECIAL DISPLAY for the month of November will consist of John
Hunter's preparations of the teeth on which he based his *Natural History
of the Human Teeth*, published in 1771.

DIARY FOR NOVEMBER

Tues.	3		Final Fellowship Examination (General Surgery) begins.
Wed.	4		D.T.M. & H. Examination begins.
		5.00	MR. W. S. MACK—Urology Lecture.*
Thur.	5	5.00	PROF. H. W. BURGE—Hunterian Lecture—Vagal nerve section in chronic duodenal ulceration.*
Tues.	10	5.00	MR. T. WARD—Fractures of the facial bones—I.
		6.15	MR. B. E. D. COOKE—Fibro-osseous swelling of the jaws.—I.
Thur.	12		D.A. Examination begins.
		2.00	Ordinary Council.
		5.00	MR. A. DICKSON WRIGHT—Bradshaw Lecture—Surgery of the biliary passages.*
		5.00	MR. B. E. D. COOKE—Fibro-osseous swelling of the jaws. II.
		6.15	MR. N. L. ROWE—The maxillary antrum in relation to dental surgery.

Tues. 17   5.00   PROF. R. L. HUCKSTEP—Hunterian Lecture—Recent Advances in the surgery of typhoid fever.*

        5.00   MR. J. WATSON—Head injuries.

        6.15   MR. P. CLARKSON—Surgical correction of deformities of the jaws.

Thur. 19   5.00   DR. L. W. PROGER—Erasmus Wilson Demonstration—New additions to the museum.*

        5.00   DR. I. R. H. KRAMER—Pulp reactions to operative proceedings.

        6.15   MR. B. W. FICKLING—Soft tissue infections of the face and neck.

Fri.   20   5.00   Board of Faculty of Dental Surgery.

Tues. 24   5.00   MR. J. C. HOUSTON—Blood diseases in relation to dentistry.

        6.15   DR. L. FORMAN—Oral manifestations of skin diseases—I.

Wed. 25   First L.D.S. Examination begins.

Thur. 26   D.P.M. Examination (Part 1) begins.

        5.00   DR. B. COHEN—Secondary tumours of the jaws.

        5.00   MR. NORMAN R. BARRETT—Arris and Gale Lecture—Some anatomical and pathological considerations concerning multiple hydatid cysts in the chest.*

        6.15   DR. L. FORMAN—Oral manifestations of skin diseases—II.

DIARY FOR DECEMBER

Tues.   1   5.00   DR. M. J. F. MCARDLE—Facial pain.

        6.15   DR. V. GOLDMAN—General Anaesthesia—I.

Wed.   2   Second L.D.S. Examination begins.

        5.00   Board of Faculty of Anaesthetists.

Thur.   3   Pre-medical Examination, D.L.O. Examination (Part 1) and D.P.M. Examination (Part II) begin.

        5.00   DR. H. G. H. RICHARDS—Erasmus Wilson Demonstration.*

        5.00   MR. S. H. WASS—Osteomyelitis of the jaws.

        5.30   MR. NORMAN R. BARRETT—Otolaryngology Lecture.*

        6.15   DR. V. GOLDMAN—General Anaesthesia—II.

Mon.   7   Basic Sciences Lectures and Demonstrations for Dental Students begin.

Tues.   8   4.00   DR. E. F. SCOWEN—Imperial Cancer Research Fund Lecture.*

        5.00   PROF. R. B. LUCAS—Pathology of oral neoplasms—I.

        6.15   PROF. H. C. KILLEY—Surgery in relation to prosthesis.

Wed.   9   ANNUAL MEETING OF FELLOWS AND MEMBERS.

              Primary F.F.A. Examination and D.P.H. Examination begin.

        2.30   LORD COHEN OF BIRKENHEAD—Watson-Jones Lecture.*

        3.30   Annual Meeting of Fellows and Members.

Thur. 10   First Membership Examination and D.L.O. Examination (Part II) begin.

        2.00   Ordinary Council,

        5.00   PROF. H. H. NIXON—Hunterian Lecture—An experimental study of propulsion in isolated loops of intestine and application of the findings in the surgery of neonatal intestinal obstruction.*

        5.00   PROF. R. B. LUCAS—Pathology of oral neoplasms—II.

        6.15   MR. G. T. HANKEY—Disorders of the mandibular joint.

Fri.   11   Date of Election of Fellows to the Board of Faculty of Anaesthetists announced.

Tues. 15   5.00   DR. W. CAMPBELL—Radiology of the facial bones—I.

        6.15   MR. C. R. MCLAUGHLIN—Cleft palate.

Thur. 17   5.00   DR. R. M. H. MCMINN—Arris and Gale Lecture—The cellular anatomy of experimental wound healing.*

        5.00   DR. W. CAMPBELL—Radiology of the facial bones—II.

        6.15   MR. TERENCE WARD—Fractures of the facial bones—II.

Fri.   18   Basic Sciences Lectures and Demonstrations and Dental Lecture and Clinical Conferences end.

Thur. 24   College closed.

Fri.   25   Christmas Day.   College closed.

Sat.   26   College closed.

Mon. 28   College closed.

Thur. 31   D.I.H. Examination begins.

* Not part of courses.

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CONGENITAL INTESTINAL ATRESIA AND STENOSIS IN THE NEWBORN

OBSERVATIONS ON ITS PATHOGENESIS AND TREATMENT

J. H. Louw, Ch.M.

Professor of Surgery, University of Cape Town; Head of the Department of Surgery, Groote Schuur Hospital and Red Cross War Memorial Children's Hospital, Cape Town

MR. PRESIDENT, MEMBERS of the Council, Ladies and Gentlemen,

First I wish to say how deeply I appreciate the signal honour of being able to deliver a Moynihan Lecture in this College to such a distinguished gathering today. This is indeed a fitting occasion to pay tribute to Lord Moynihan because he did so much for the Association of Surgeons. He was largely responsible for the establishment of the Association; he was a member of the first Council; he was later President and he gave the Presidential Chain of Office and Badge.

I cannot hope to emulate Lord Moynihan's eloquence but I trust that the substance of my lecture will bear testimony to the wisdom of his convictions and influence of his writings. I refer in particular to his contention that " surgery is an instrument of research," his emphasis on the surgeon's unparalleled opportunity for lifelong research by direct observation of the " pathology of the living " and his appreciation of the need for " vital experiments."

It is the purpose of this paper to present to you certain clinico-pathological and experimental data in support of a century-old theory on the causation of congenital intestinal atresia. Refinements in the treatment of the condition which are based on this concept, and which have resulted in a considerable reduction in the mortality rate, will be briefly discussed.

The investigation was commenced in 1951 when I had the privilege of working at the Hospital for Sick Children, Great Ormond Street, because it was realised that the mortality of intestinal atresia even in the best paediatric surgical centres of this country and abroad still exceeded 80 per cent. (Louw, 1952). It was felt that this high mortality rate, like that of many other congenital anomalies, was due, in part at least, to a lack of knowledge of their exact origin. Bacon's (1623) aphorism " To know truly is to know by causes " is as true today as it was three and a half centuries ago and until we have a clear concept of the aetiology of congenital malformations, the significant contribution which they are making to infant mortality and morbidity, and to physical handicaps in later life, cannot be materially reduced.

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The pathogenesis of congenital intestinal atresia has not been satis-factorily explained. Since 1812 when Meckel first suggested that the anomaly was due to a peculiar aberration of growth, no less than sixteen hypotheses on the aetiology have been advanced (Barnard, 1958). Of these, only two merit serious consideration, viz., Tandler's (1902) " Theory of Imperfect Recanalisation " and " The Theory of Vascular Insufficiency " popularised by continental writers during the late nine-teenth century.

HYPOTHESES ON THE AETIOLOGY OF INTESTINAL ATRESIA

Tandler's Theory

In 1902 Tandler showed that the human duodenum passes through a solid stage during embryonic life. This is due to epithelial proliferation which commences in the fifth week and soon obliterates the whole lumen of the bowel. The lumen reforms by vacuoles which coalesce and is completely re-established at the end of the eighth week. Tandler suggested that an arrest of the development of the duodenum during the solid stage (fifth to eighth weeks) would result in intestinal atresia.

The embryological observations were confirmed by Forsner (1907), Kreutner (1909), Johnson (1910) and Ager (1910). Tandler's theory became widely accepted all over the world and it is still the explanation given by most authorities on the subject (Bremer, 1953). However, some doubts on the validity of this thesis have been expressed in recent years (Louw and Barnard, 1955 ; Nixon, 1955).

The Theory of Vascular Insufficiency (Fig. 1)

This theory, which originated exactly 100 years ago, is based on the belief that interruption of the blood supply to a segment of the sterile foetal bowel may lead to arrest of growth, atrophy and even complete disappearance of the affected portion of intestine. During the latter half
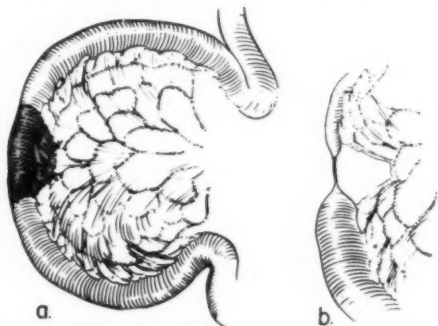
Fig. 1. The Theory of Vascular Insufficiency. Infarction of a portion of the bowel by a variety of strangulating obstructions results in aseptic necrosis and disappearance of the affected segment.

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of the nineteenth century, many workers attributed atresia to infarction of the foetal bowel. Examples were published in which the appearances suggested strangulation by various mechanisms, e.g., volvulus, intussusception, herniation, kinks, bands, etc. (Streubel, 1859 ; Widerhofer, 1859 ; Fiedler, 1864 ; Middleton, 1868 ; Ahlfeld, 1873 ; Epstein and Soyka, 1878 ; Gaertner, 1883 ; Kirchner, 1886 ; Rutherford, 1909). Similar reports have appeared more recently (Morton, 1923 ; Nixon, 1955 and 1956 ; Parkkulainen, 1958).

This hypothesis was very popular especially on the Continent during the latter half of the last century but was almost completely discarded when Tandler offered his alternative explanation. In recent years there has been a revival of interest in the vascular mechanism and I hope to show today that there are very good reasons for this.

MATERIAL

The primary object of our investigations was to test the validity of these two hypotheses, first by a critical evaluation of " the pathology of the living " and, secondly, by " vital experiments " designed to reproduce the anomaly in animals.

The clinico-pathological data were obtained from :

(1) A personal analysis of the records of seventy-nine cases of intestinal atresia treated at the Hospital for Sick Children, Great Ormond Street, up to the end of 1951. These findings have been previously reported (Louw, 1952).

(2) Direct observations of the living pathology in 35 cases treated in the University of Cape Town Teaching Hospitals from 1952 to 1958.

The experimental data were obtained from forty-four experiments performed on pregnant animals, thanks to the untiring efforts of my associate and colleague, Dr. Chris. Barnard.

CLINICO-PATHOLOGICAL FEATURES

A brief review of the salient clinico-pathological features of intestinal atresia is not only pertinent to this discussion but essential because if any single mechanism is to be postulated as a cause of intestinal atresia it can be valid only if it accounts for most, if not all, of the pathological findings in patients suffering from the anomaly.

One newborn baby in every three thousand enters this world suffering from intestinal atresia or stenosis (Louw, 1952). Very soon " the infant mewling and puking in the nurse's arms " will become gravely ill and grossly distended. Unless the condition is promptly recognised and treated, the baby will die of acute intestinal obstruction.

At operation or autopsy the bowel above the point of obstruction is enormously distended, often up to adult size (Fig. 2). The intestinal walls are hypertrophied as well as dilated indicating that the acute postnatal obstruction is superimposed on a chronic prenatal obstruction (Nixon, 1955 and 1956).

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Fig. 2. Autopsy findings in intestinal atresia.   Note the dilatation of the duodenum and the collapsed, worm-like appearance of the distal bowel.

The distal intestinal loops are small, collapsed and worm-like. In fully 40 per cent. of our cases with complete atresia the bowel below the obstruction contained some meconium sometimes with epithelial squames and in a small number (10 per cent.) obvious bile was present. Bryan (1923) reported a case where hair was present). It should be recalled that bile is not secreted until the eleventh week of embryonic life and the skin has no squames until the third month. Since the solid stage of the duodenum exists between the fifth and eighth weeks, Tandler's Theory cannot be valid in patients who have bile and squames in the bowel beyond the lesion. On the other hand, vascular interference may occur any time during pregnancy and thus bile may or may not be present in the distal intestine.

The occlusion itself (Fig. 3)

Bland Sutton (1889) described three types of atresia. To these may be added a fourth, namely incomplete occlusion or stenosis. The features of these are as follows :

1. *Stenosis.* There is a zone of narrowing of the intestinal lumen which in many cases will barely admit a probe. This type of anomaly can be accounted for on a basis of either hypothesis.

2. *Atresia type I.* One or more septa or diaphragms completely occlude the lumen. These septa may contain all the intestinal layers in duplicate, but more frequently there are only a few muscle fibres or simply two mucous coats. Since the lumen of the embryonic duodenum contains epithelial elements only (Louw, 1946 ; Johnson, 1910), Tandler's Theory cannot account for the presence of muscle fibres or even well-formed muscle in some septal occlusions.

3. *Atresia type II.* The proximal bowel terminates in a blind end and the distal bowel commences similarly, the two ends being joined by a thread-like structure devoid of a lumen. This cord usually consists of fibrous tissue only but may contain all the intestinal layers (Glover, Smith and Eitzen, 1942 ; Sheldon, 1926). The adjoining mesentery may be intact or there may be a V-shaped defect corresponding to the atretic segment. Either theory would explain the fibrous band but Tandler's Theory cannot account for a gap in the mesentery.

4. *Atresia type III.* This is like type II but the proximal and distal blind ends are completely separated with no connecting band. The total length of the small bowel may be considerably reduced. The adjoining mesentery always has a V-shaped defect corresponding to the missing segment. This type, which occurs commonly in the jejunum and ileum,

STENOSIS.

ATRESIA — TYPE I.

ATRESIA — TYPE 2.
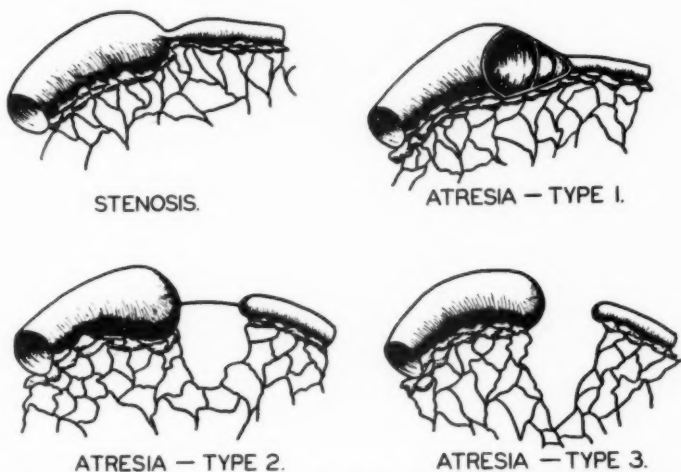
ATRESIA — TYPE 3.

Fig. 3. The four types of intrinsic occlusion (in Type II atresia the mesentery may be intact).

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cannot possibly be accounted for on a basis of Tandler's Theory but is well-explained by the vascular hypothesis.

Blood-supply to atretic area

A striking feature of types II and III atresias is that several inches of the bowel immediately proximal to the lesion are grossly distended and blown out into a bulbous end (Fig. 4). This end was frankly gangrenous or partially necrotic with or without perforation in fully 15 per cent. of our cases. More important, however, is mucosal necrosis which occurred in 30 per cent. of our patients sometimes at a very early stage, e.g., within thirty-six hours of birth (Fig. 5). It must be stressed that this vascular insufficiency of the bowel wall, although sometimes aggravated by postnatal volvulus of the heavy, enlarged and overloaded proximal loops, frequently occurred without any evidence of postnatal strangulation. The changes obviously suggest some pre-existing impairment of the blood-supply to the blind end and hence a " vascular " origin. In this connection it should be remembered that a V-shaped defect was present in fully 40

Fig. 4. Ileal atresia resected at operation. Note (in sequence) the enormous bulbous proximal blind-end with an area of necrosis, the atretic segment, the minute distal bowel and the remains of a foetal intussusception.

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per cent. of the jejuno-ileal atresias in our series and in such cases the blind ends are supplied by what are virtually end arteries. Moreover, cases have been described where there was evidence of obliterative endarteritis of the marginal vessels along the V-shaped defect in the

Fig. 5. Ileal atresia resected at operation thirty-six hours after birth. Note the dark, necrotic mucosa of the proximal blind-end. On external examination it appeared perfectly viable.

mesentery (Davis and Poynter, 1922), and there are also records of absent major vessels such as the pancreatico-duodenal and inferior mesenteric (Louw and Barnard, 1955 ; Kuttner, 1872 ; Durante and Syron, 1897 ; Wyss, 1900 ; Jaboulay, 1901 ; Gresel, 1905). Obviously none of these vascular changes can be accounted for by simple failure of recanalisation of the intestinal lumen.

Distribution of the lesions

Table I. Distribution of atresia and stenosis (average of collected series).

TABLE I

DISTRIBUTION OF LESIONS

	Cape Town 35 cases	Gt. Ormond St. 79 cases	Boston 211 cases*	Average (Literature)
Duodenum	15	31	71	36%
Jejunum	4	12	24	12%
Ileum	9	20	99	40%
Colon	4	3	7	4%
Multiple	3	13	10	8%

* After Gross (1953).

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The duodenum and terminal ileum are the common sites involved.   n
our series more than three-quarters of the lesions occurred in these are: s.
(It should also be noted that multiple occlusions occurred in appro i-
mately 10 per cent. of cases.)

These areas which Bland Sutton (1889) referred to as the sites of
" embryological events " are predisposed to vascular insufficiency.
First, they have a somewhat precarious blood-supply in the foetus
(Denney and Sloan, 1932).   Secondly, the terminal ileum is liable to
strangulation by snaring at the umbilical ring, volvulus or intussusception,
while the blood-supply to the duodenum may be compromised by kinking
at the duodeno-jejunal flexure, compression by bands or torsion due to
the development of the pancreas.

On the other hand this predilection for certain areas cannot be explained
on the basis of imperfect recanalisation. Moreover, a solid stage has not
been demonstrated in any part of the embryonic bowel beyond the
duodenum and this is a most serious objection to Tandler's Theory.

TABLE II
TYPES OF OCCLUSION

	Cape Town 35 cases	Gt. Ormond St. 79 cases	Average (Literature)
Stenosis	10*	21	One third
Atresia : 1. Membrane 2. Band 3. Gap	7† 8 } 25 10	19 21 } 58 18	Two thirds

* 7 in duodenum } 80 per cent. of intrinsic duodenal lesions.
† 5 in duodenum }

It should be noted that in the duodenum 80 per cent. of the lesions are
stenotic or membranous whereas in the jejuno-ileum more than three-
quarters are of types II and III atresias, i.e., blind-ends (Table II).   This
suggests that slightly different mechanisms may be responsible for lesions
in different sites and will be discussed later.

Associated malformations of other organs

Table III.   The incidence of other serious malformations in patients suffering from
duodenal and jejuno-ileal atresias.

TABLE III
SERIOUS ANOMALIES ASSOCIATED WITH SMALL INTESTINAL ATRESIA

	Duodenum	Jejuno-Ileum
Number of cases	47 (32 G.O.S., 15 C.T.)	57 (41 G.O.S., 16 C.T.)
Number with other anomalies	25 (53%)*	5 (9%)†
Number of mongols	16 (34%)	0

*Mainly nervous, cardiac, oesophageal and rectal.
† Mainly Gastro-intestinal (malrotation not included).

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A striking feature of our material has been the great frequency of other malformations in patients suffering from duodenal occlusions. Major malformations were present in more than half of them and fully one third of the cases were Mongols (Bodian, et al., 1952, Louw, 1952). In infants with jejuno-ileal lesions, on the other hand, serious anomalies of other systems were present in less than 10 per cent. and there was no case of Mongolism. This also suggests that slightly different mechanisms may be responsible for lesions in different sites and will be discussed later.

From these observations of the living pathology there seemed to be so many objections to Tandler's Theory that it was felt that the hypothesis did not warrant further consideration. On the other hand, the vascular theory served to explain most, if not all, the findings. It seemed as if vascular insufficiency results not merely in arrest of growth but in actual disappearance of the affected portion of the foetal bowel. The hypothesis is supported by the experimental work of Laufman and others (1949)

Fig. 6. Portion of the gravid uterus exposed at operation. Note the large vessels on the left overlying the placental site.

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Fig. 7.   Uterus and membranes incised.   Skin of the puppy drawn into the incision
to prevent escape of amniotic fluid.

and confirmed by us (Louw and Barnard, 1955) which has shown that devascularised, sterile loops of bowel left in the peritoneal cavity of dogs become converted into fibrous cords or disappear entirely. Because foetal bowel is sterile, infarction probably results in absorption of the involved segment with, at the most, complicating meconium peritonitis.

EXPERIMENTAL WORK BASED ON THE VASCULAR HYPOTHESIS

Any hypothesis, however ingenious and reasonable it may be, is not science without experimental verification. In his Romanes Lecture " The Advances of Medicine " given at Oxford in 1932, Lord Moynihan stressed
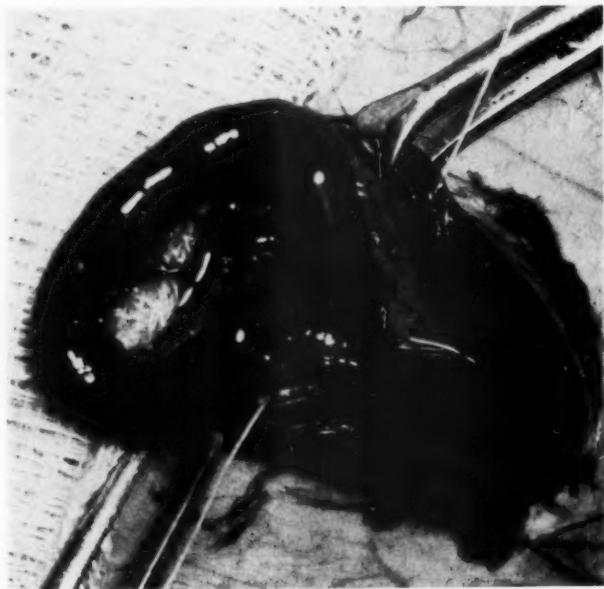
Fig. 8. Loop of foetal bowel delivered and mesenteric vessel ligated.

Fig. 9. Loop of ileum strangulated by creating a volvulus which is maintained by a silk ligature.

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the importance of the experimental approach and pointed out that " without experiment on living animals . . . advance . . . cannot continue " (Bateman, 1940). Since direct observation of the developing human foetus is not possible, the " vascular hypothesis " was tested on living foetuses

Fig. 10. Autopsy findings in a puppy born alive forty-eight hours after ligation of mesenteric vessels. Note the collapsed, infarcted segment commencing to disintegrate, the V-shaped defect in the mesentery and the proximal and distal viable ends starting to separate from the infarcted segment.

of animals, the purpose of the experiments being to reproduce the anomaly by interrupting the blood supply to a segment of the foetal bowel.

Method

The experimental work was carried out on mongrel bitches of average size and forty-five to fifty-five days pregnant. The animal was operated upon and the gravid uterus visualised (Fig. 6). Without lifting the uterus out of the peritoneal cavity, the foetus situated in the middle of the right horn was located and its placental site carefully identified. The foetus was rotated so that its lateral abdominal wall came to lie adjacent to the area of the uterine wall to be incised and the uterus and membranes were then

opened for half to two-thirds of an inch (Fig. 7). Then an incision one-quarter to one-third of an inch long was made in the abdomen of the foetus and a loop of small intestine delivered into the wound. Two methods were used to infarct a segment of bowel, viz., ligation of one or more mesenteric vessels (Fig. 8) and creation of a strangulating obstruction (Fig. 9). Thereafter the puppy was replaced, the various wounds closed and the mother allowed to go to term.

Results

After perfection of the technique, 80 per cent. of the puppies operated upon in utero were born alive at term. They were sacrificed for examination soon after birth.

The morbid anatomical findings depended on how soon the puppy was born after interference with the intestinal blood-supply. In puppies

Fig. 11. Autopsy findings in puppy born ten days after infarction of a segment of ileum by ligation of mesenteric vessels. Note the formation of proximal and distal blind-ends connected by a solid fibrous cord.

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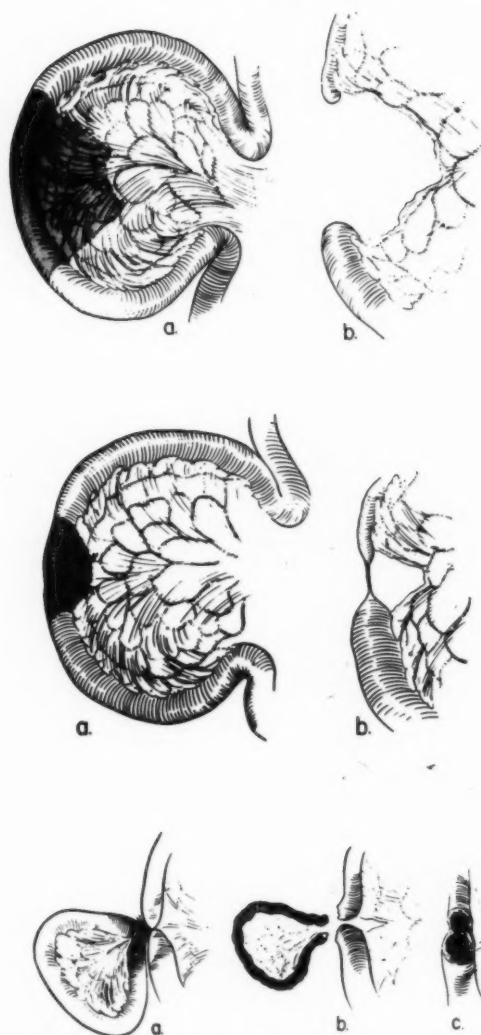
Fig. 12. Diagrammatic representation of the development of various types of atresia. Stenosis develops when the vascular interference is incomplete.

born twelve to fourteen days after the operation, an anomaly identical with that found in some infants with intestinal atresia was produced. In puppies born at earlier stages the evolution of the lesion could be studied.

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It was clearly shown that devitalised segments of bowel disintegrated rapidly (Fig. 10) with subsequent gradual absorption of the dead tissue until only a thin fibrous strand or no tissue remained. The proximal and distal bowel separated from the devascularised segment and closed off to form rounded blind ends (Fig. 11). Adhesions formed in the vicinity but tended to disappear with time unless there was perforation of the bowel with leakage of meconium when frank meconium peritonitis developed (this was very rare). Subsequently the proximal bowel became gradually distended and hypertrophied while persistence of peristalsis tended to empty the distal bowel.

The final outcome depended upon the site and extent of vascular interference (Fig. 12). When branches of the mesenteric vessels were ligated close to their origin, the proximal and distal blind-ends became completely separated with a corresponding gap in the mesentery or connected

Fig. 13. Autopsy findings in a puppy born eleven days after infarction of a segment of bowel by creation of a strangulating obstruction. Note that the infarcted segment has completely disappeared while the proximal and distal blind-ends have fused to form a diaphragm.

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Fig. 14. Photomicrograph of specimen shown in Fig. 13 showing the intimate fusion of the two blind-ends to form the septum (the distal segment broke off during preparation of the slide).

by a fibrous band with or without a mesenteric defect (Fig. 11). When the blind-ends formed in close proximity as a result of a strangulating volvulus, the ends fused to form a diaphragm or membrane (Figs. 13 and 14). When the vascular interference was incomplete, the result was intestinal stenosis (Fig. 15).

DISCUSSION ON THE THEORY OF VASCULAR INSUFFICIENCY

The above mentioned experimental observations provided conclusive evidence that interruption of the blood-supply to the foetal bowel may

result in a progression of intestinal anomalies from widely separated blind-ends at the one extreme to intestinal stenosis at the other (Table IV).

Table IV. Summary of results of experiments.
TABLE IV
EXPERIMENTAL PRODUCTION OF INTESTINAL ATRESIA

Total number of pregnant dogs operated upon 41
Number of failures due to death of puppy in utero, or cannibalism 9

RESULTS OF 32 SUCCESSFUL INVESTIGATIONS

Type of Vascular interference	No.	Incomplete development due to early labour	Complete development of pathology			
			Stenosis	Atresia		
				Type I	Type II	Type III
Ligation of ileal vessels ..	24	8	3	Nil	5	8
Strangulation of segment of ileum	8	4	Nil	4	Nil	Nil

In addition, atresia of Type II and Type III was produced in three rabbits by same method.

It should be pointed out that there were no negative results, no false positive results and that the sibling puppies who were normal in every respect acted as controls.

The clinical and pathological observations already referred to strongly suggest that local (abdominal) occlusion of the blood vessels to a portion of bowel may in fact occur in the human foetuses. It should be recalled that during the development and rotation of the foetal bowel conditions arise which favour the occurrence of kinks, herniations, volvuli, intussusception, etc., which may interrupt the blood supply to a portion of the
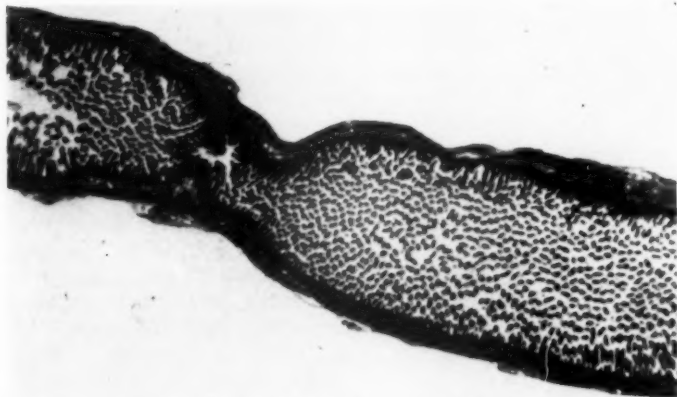
Fig. 15. Intestinal stenosis produced by partial infarction of the bowel.

Fig. 16.   Ileal atresia resected at operation. Note the remains of a foetal volvulus.

bowel.   That such " accidents " do in fact occur has been recorded on many occasions.   In Cape Town we have now had six cases where the operative findings clearly indicated that segments of the foetal bowel had been strangulated by such mechanisms, viz. : two cases of volvulus (Fig. 16), three cases of intussusception (Figs. 4 and 17) and one case of snaring of the foetal bowel at the umbilical ring (Fig.18).   It is therefore suggested that when intestinal atresia occurs as an isolated lesion (which is the rule in cases with jejuno-ileal occlusions) it is due to local vascular interference to the affected segment of bowel by strangulating obstructions (Fig. 19—Local Factors).

On the other hand in cases where there are associated malformations of other systems (which is common in cases with duodenal atresia) general rather than local factors are probably responsible.   However, it is more

Fig. 17. Ileal atresia resected at operation. Note the remains of a foetal intussusception.

than likely that the same principle, viz.: vascular insufficiency, governs the formation of both the intestinal atresia and the other anomalies. John Hunter in his treatise on Monsters expressed the belief that but one principle governed the formation of congenital malformations and this is widely accepted by teratologists today (Ingalls, et al., 1956, 1958; Woollam, 1958).   Recent studies in experimental teratology have provided abundant proof that environmental factors are frequently responsible for congenital malformations (Ingalls, et al., 1952, Woollam, 1958). Among these factors anoxia occupies a prominent place. Ingalls and his associates (1950, 1952, 1956, 1957, 1959) have provided very good experimental evidence that gross structural defects induced by hypoxia have their genesis in primary disturbances of the blood vessels supplying the affected structure. They have clearly demonstrated that the growing blood vessels supplying actively differentiating tissues, thrombose and disintegrate (Tedechi, et al., 1956; Ingalls, 1959).   In this way the effects of temporary anoxia on the vessels may cause permanent impairment of the blood supply with infarction of the structure supplied.

By linking these observations with our findings it seems reasonable to conclude that many cases of duodenal atresia have their origin in

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foetal hypoxia complicated by damage to the blood vessels supplying the duodenum (Fig. 19—General Factors). In this connection we have shown that during the eighth and ninth weeks of pregnancy the second part of the duodenum is a highly dynamic area and the most actively growing part of the gastro-intestinal tract (Louw, 1946), thus being vulnerable to the effects of hypoxia at this time. Since Ingalls (1947) has shown that Mongolism can be related to anoxia during this very period, it is not surprising that Mongolism and duodenal atresia often coexist.

In view of the above considerations it is submitted that *the theory of vascular insufficiency accounts for all the clinico-pathological features of congenital intestinal atresia* and that there is no need to look for an additional or alternative explanation.

TREATMENT

Returning to the original reason why this investigation was undertaken, viz.: the excessively high mortality rate of congenital intestinal

Fig. 18. Snaring of the intestine at the umbilical ring with the formation of a spontaneous " double-barrel " ileostomy.

atresia prior to 1952, I would like to consider, for a moment, in what way the concept of a vascular origin of the lesion has affected the treatment since that time.

The high mortality up to 1952 was most noticeable in patients suffering from Types II and III atresias, i.e., blind-ends (Louw, 1952). These

PATHOGENESIS OF INTESTINAL ATRESIA

Local Factors	General Factors
(Strangulation, Etc.)	(Hypoxia, Etc.)
↓	↓
Critical interference with blood supply to a segment of bowel	Critical interference with blood supply to : 1. Actively differentiating tissues 2. Tissues with precarious blood supply
↓	↓
Death of affected segment of bowel	Death of affected tissues
↓	↓
Intestinal atresia	Other anomalies

Fig. 19.   Diagrammatic representation of the theory of vascular insufficiency.

lesions which are mainly located in the jejunum and ileum (and which account for three-quarters of atresias of the jejuno-ileum) used to be treated by direct anastomosis of the proximal and distal blind-ends. One of the main causes of death was " post-operative obstruction." Such obstruction has been attributed to adhesions (Gross, 1953) but we found that there was usually no evidence of mechanical obstruction. Our cases clearly showed that the proximal dilated blind-ends failed to return to normal size and remained large, flabby and friable despite a perfectly patent anastomotic stoma (Fig. 20). It was also observed that peristalsis in these blind-ends was ineffective and Nixon (1955, 1956) has shown experimentally that dilated and hypertrophied segments of intestine lack proper propulsive activity and so produce a " functional " obstruction.

Paradoxically, it was found that the results of surgical treatment were much better in babies where obvious necrosis of the proximal blind-ends had prompted the surgeon to do a resection. In this connection it must be repeated that in fully 30 per cent. of our cases the blind-ends showed evidence of mucosal necrosis but more than half of them were apparently viable on external examination and therefore were not resected (see Fig. 5).

It should be noted, also, that direct anastomosis done for membranous and stenotic lesions (80 per cent. of duodenal occlusions) was more successful. The overall mortality rate was considerably lower and " post-operative obstruction " much less troublesome (Louw, 1952).

Since we believed in the vascular origin of atresia from the outset, it was felt that the ineffective peristalsis of blind-ends as well as the early " tension gangrene " observed in one-third of the cases was due to vascular insufficiency (Louw, 1952). Nixon (1955-1956) attributes the ineffective contractions simply to the effects of pre-existing chronic obstruction during foetal life. However, this does not explain the early onset of " tension gangrene " nor the remarkable difference in prognosis between membranous (duodenal) and other (jejuno-ileal) lesions treated by direct anastomosis. It is therefore suggested that the blind-ends, being adjacent to the infarcted segment of bowel, are partially affected by the vascular interference responsible for the atresia (Fig. 21). The damage inflicted is not sufficient to cause death of these areas, but it seems reasonable to assume that they are left with a precarious blood-supply. Any additional strain on the circulation such as the tension that builds

scale 0·5 cm.
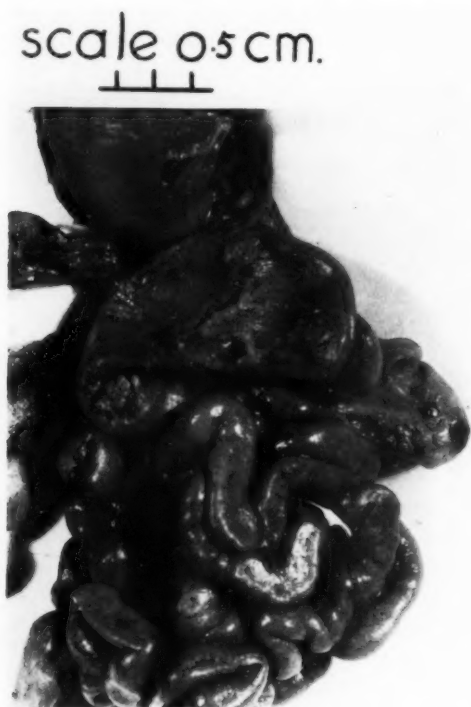
Fig. 20. Autopsy specimen of a case of intestinal atresia treated by direct anastomosis. Although the anastomotic stoma was widely patent, there was postoperative obstruction due to impaired function of the dilated proximal blind-end.

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EFFECTS OF INFARCTION OF FOETAL BOWEL.
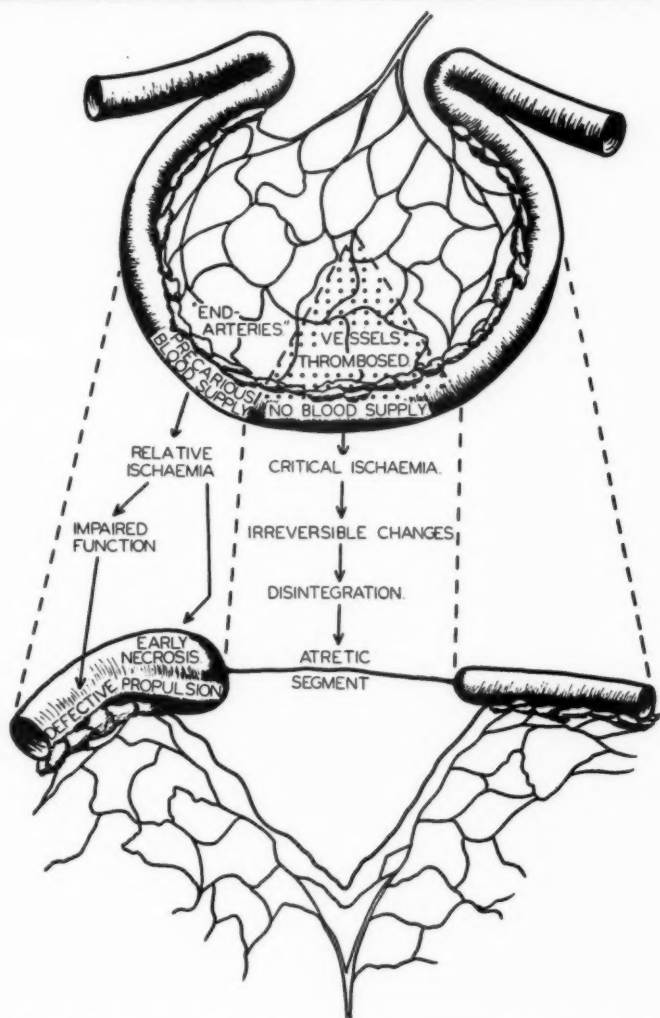
Fig. 21. Suggested explanation for the defective function in the blind-ends adjoining an atretic segment.

up in the proximal end after birth may precipitate early necrosis. Furthermore it is well known that partial ischaemia of the bowel may lead to

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impaired function and produce symptoms of an obstructive nature with out structural damage (Klein, 1921 ; Mavor and Michie, 1958).

The degree of functional impairment will obviously depend on the extent and severity of the vascular interference responsible for the atresia. In stenotic or membranous lesions where the interference is only slight, the adjacent bowel will probably not be affected. Direct anastomosis should, therefore, be satisfactory and this is in fact so in practice, e.g., in duodenal occlusions (80 per cent. stenotic or membranous) direct duodeno-jejunostomy is still the method of treatment and the present-day results are excellent (since 1952 we have operated upon fifteen cases with three deaths). On the other hand, in atresias of Type II and III (i.e., blind-ends) where the vascular interference is more profound, permanent functional and even structural changes may be anticipated in the adjoining bowel with consequent disordered peristalsis. Direct anastomosis should therefore be unsafe and this is in fact so even today (mortality over 70 per cent.—see Table V).

Table V. Operative mortality in cases of jejuno-ileal atresias treated by direct anastomosis and by resection.

TABLE V
EFFECT OF RESECTION ON MORTALITY OF JEJUNO-ILEAL OCCLUSIONS

	Cape Town 1952-1958	Great Ormond Street † 1949-1955
Without resection ..	72 per cent. 7 operations	71 per cent. 17 operations
With resection	22 per cent.* 9 operations	32 per cent. 16 operations

* Swenson's (1959). Results similar.
† After Nixon (1956).

In view of the above considerations a strong plea was made early in 1952 that 10 to 15cms. of the proximal blind-end and 2 to 3cms. of the distal blind end should be resected in dealing with jejuno-ileal atresias (Louw, 1952). This has been done by most of the surgeons at Great Ormond Street since that time (Nixon, 1955 and 1956) and has also been our practice in Cape Town. Apart from removing devitalised tissue, resection reduces the great discrepancy in size between the two blind-ends and so facilitates end-to-end anastomosis.

The results of this modification in technique have been most gratifying (Table V). In Cape Town and Great Ormond Street the mortality of jejuno-ileal lesions still treated by direct anastomosis has remained greater than 70 per cent. (In the Cape Town group of seven cases there were only two survivors—one had a high jejunal atresia and the other a membranous occlusion.) On the other hand, the mortality of lesions treated by resection during the same period has been reduced to less than one-third. (In the Cape Town group of nine cases there were two deaths and one of these infants had associated long-segment Hirschsprung's

disease.) Swenson (1959) has had similar success with resection—two deaths in ten consecutive cases. The vastly improved results obtained by resection have been all the more gratifying because the survivors have remained well and are growing up normally in every way, thus re-affirming Bacon's aphorism " To know truly is to know by causes."

CONCLUSIONS

It is now well established that a specific kind of defect may be caused by wholly different agents as diverse as hypoxia, irradiation, nutritional disorders, endocrine disturbances and infections (Ingalls, et al., 1952, 1957). Also, any one of these agents may give rise to many different anatomical abnormalities. It is submitted for your consideration that basically all these agents act by a single mechanism, viz. damage to the blood vessels supplying the affected structure and that many anatomically unrelated malformations have a common pathogenesis in vascular insufficiency.

A great deal remains to be done in the field of congenital abnormalities and the advances during the next few decades can be unpredictably great. To those of you who are sufficiently interested in this problem and wish to pursue it further, I would like to quote a remark by Dr. William Ladd of Boston (1948) who said—" If . . . the surgeon . . . gains more happiness out of making advances in lowering the mortality and improving the lot of those afflicted with congenital anomalies, this field of surgery offers great and very gratifying possibilities." I can assure you that no reward in surgery equals that of restoring the health of a sick or deformed child.

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THE MICRO-ANATOMY OF THE BREAST

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THE STRUCTURE OF the body is studied by two methods principally ; gross anatomy covers all aspects that are visible to the naked eye, histology is concerned mainly with cells.   There is a realm between these two, including the minute architecture of ducts and glands, which is relatively unexplored.   Using current methods of examination, a three dimensional concept of tissues can only be obtained by building models from numerous thin sections, which is a laborious task.

Method

In recent years interest has revived in the use of thick sections of tissue ; this was, of course, the original method in days before the invention of the microtome when sections were cut freehand.   One of these methods (Chesterman and Leach, 1949) has proved particularly valuable (Parks, 1956).   Blocks of tissue are impregnated with low viscosity nitro-cellulose, hardened, and cut into sections of thickness varying between 150   and 500μ.   Each section has a number indelibly stamped on the cellulose which is never removed from the tissue.   Labelling, therefore, is permanent and serial sections cannot get mixed in the process of staining and final preparation.   The stain used is anthracene blue which readily penetrates the cellulose.   Nuclei and epithelium are coloured pale purple, connective tissue is usually unstained.   The translucent connective tissue is the medium through which ducts and other epithelial structures are seen. Once the sections have been cleared to render them transparent they can be examined in a Petri dish.   They are tough enough to withstand handling without being mounted between glass and can be conveniently stored in wide-mouthed bottles.   A great deal of time and labour is saved by avoiding the usual mounting procedures.

Sections are examined with a low power stereoscopic microscope, which gives satisfactory three dimensional perception.   The magnification is not great enough to allow individual cells to be seen, but ducts and other glandular structures stand out with great clarity.   At first it is difficult to adjust to the different appearance of these sections from routine haema-toxylin and eosin thin preparations.   It is helpful to remember that the magnification is only one-tenth of that usually employed and that the sections are seen in depth.   The technique suppresses the connective tissue ; if it did not do so the preparations would be opaque.

A duct is seen as a tube which is almost transparent.   The lumen is clearly visible unless there is hyperplasia of the epithelium lining it or other ducts superimposed upon it.   The method is only of value in those

organs in which there is sufficient connective tissue between ducts to allow them to be seen. It is valueless for examination of the liver, or instance, a section of which is quite opaque. Hyperplasia of the duct epithelium, whether benign or malignant, is seen as a darkly staining structureless mass (Fig. 1). Further information about such an area can
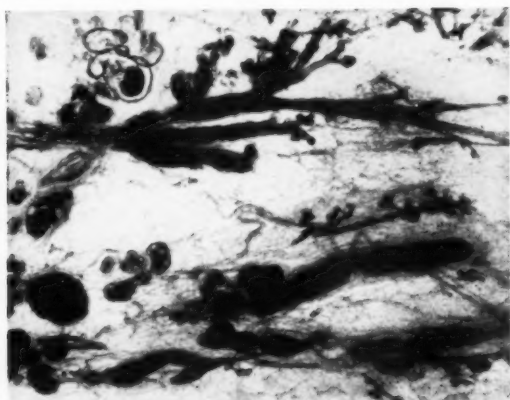
Fig. 1. The major breast ducts are distended with intra-duct carcinoma. The lobules are atrophic. The patient was sixty-five years of age, with Paget's disease of the nipple. ×20.

be obtained by punching a segment about one centimetre in diameter from the thick section. The sliver obtained is then embedded in paraffin wax and cut into thin sections which are stained and mounted in the usual manner. In this way the detailed histology and cytology of the tissue can be studied. Examination of a large block of tissue with routine serial sections is a great labour and is seldom attempted. By means of thick sections, however, a large block can be quickly scanned using a few hundred sections. If any minute object of interest is detected, it is punched out and examined histologically. This combination of techniques is thus ideal for scanning large blocks of tissue. We have used it to search for microscopic carcinoma and small nodules of sclerosing adenosis in large quantities of breast tissue.

The material on which this study is based consists of over one-hundred surgical biopsy specimens and, in addition, fifty entire breasts obtained at autopsy by Mr. J. L. Hayward. All of these were cut into serial sections, more than 40,000 of which have been prepared.

In a brief review of this nature it is not possible to refer to the extensive work of previous investigators in this field ; I hope to do so elsewhere. I propose to deal only with those aspects of breast anatomy which are particularly suited for study with the thick section technique. Even so,

the subject is of such magnitude that not more than a sketch can be given in the space available.

Basic structure

The main breast ducts arise from the lactiferous sinuses in the nipple; they divide many times to supply roughly pyramidal areas. Subsidiary ducts arise from the side of the main stems and quickly break up into short branches. The **lobules** are found at the end of these branches resembling clusters of grapes (Fig. 2 (a)). Attention will be concentrated
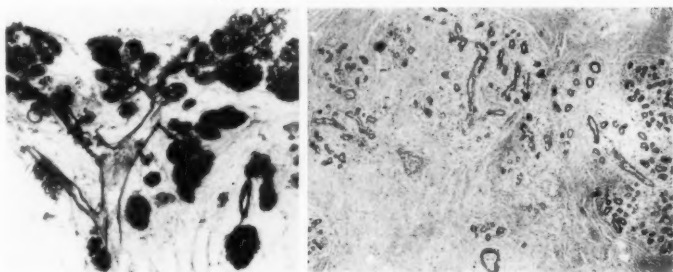
Fig. 2.
(a) In this section of normal breast, the main duct is seen dividing into branches at the end of which the lobules are situated. ×10.
(b) A thin section has been taken through a similar area to that shown in (a). Note the distinctive intra-lobular connective tissue surrounding the ductules. ×20.

on them in the ensuing discussion because they appear to be the most biologically active constituents of the breast and are subject to many aberrations of growth.

Each lobule, which is usually 1 to 2 millimetres in diameter, contains a complex duct system composed of **ductules** which branch several times before terminating blindly in slightly dilated club-shaped endings (Fig. 3). The ductules appear to have retained some of the potentialities of a germinal epithelium inasmuch as they respond to hormonal stimulation in pregnancy by proliferation and alveolus formation. This is one of the chief reasons why they will be considered in a different category from the rest of the duct system, a difference which will be repeatedly stressed in this paper.

The main stroma of the breast is situated around the ducts and lobules and will therefore be called the **peri-lobular** connective tissue; it is collagenous and contains a varying amount of fat. A somewhat different variety is found *within* the lobules surrounding the ductules. This is stained only faintly by routine techniques and is not so compact as the general breast stroma; it contains no fat (Fig. 2(b)). It will be referred to as the **intra-lobular** connective tissue, because of its constant association with lobular ductules or their derivatives.

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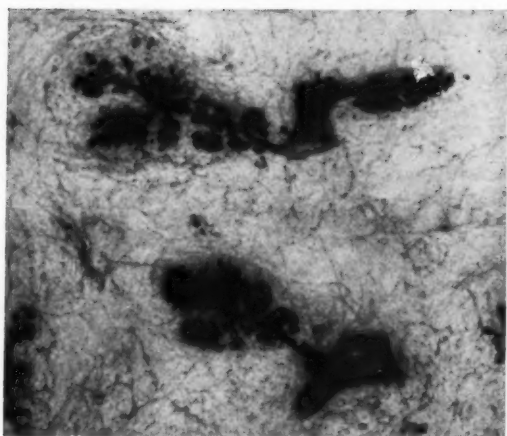
Fig. 3. Thick section showing ductules arising from a subsidiary duct. An unusually large amount of connective tissue separates the ductules which are therefore seen with greater clarity than usual. × 10.

The Life Cycle

At birth only rudiments of the main ducts are present. Minimal growth of the ducts takes place in childhood but at puberty they develop rapidly and form large numbers of lobules. If pregnancy supervenes lobules increase in number by budding from the duct system; they also develop in size and complexity. Towards the end of pregnancy the club-shaped endings of the ductules begin to expand into the true secreting **alveoli**. At the onset of lactation the alveoli dilate and commence secreting milk. This continues until the weaning of the child, after which the physiologically hypertrophied lobules shrink back to their resting size; most of them disappear altogether, leaving behind a similar number to that present before pregnancy. All traces of true alveoli disappear.

Finally, there is the **involution** which occurs in the ten-year period centred on the clinical menopause. This change is subject to considerable variation and is a more gradual one than that of pregnancy or puberty. Lobules are chiefly affected; they disappear leaving truncated subsidiary ducts which in turn gradually atrophy over the course of years. The main ducts seem to survive this process (Fig. 1). Post-menopausal involution is almost always incomplete, however. Small areas of lobular remnants are usually to be found and sometimes mature lobules may be seen generally distributed through the breast even in the ninth decade, but this is unusual.

Aberrations of growth

This simple arrangement just described never remains unmodified and may be greatly distorted. Apparent abnormalities of breast structure

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will be classified under three main headings for the purpose of this discussion. The first is **hypertrophy of the lobule** leading to an increase in ductules and *intra-lobular* connective tissue. The second heading is given to the well-known **cystic change** and the third to **duct hyperplasia** giving rise to papillomata.

Lobular hypertrophy

In young women when endocrine activity is at its height, lobular enlargement is common. It is usually simple, consisting of an increase in the number and size of ductules, together with hypertrophy of the *intra-lobular* connective tissue. This is characterized by change in size only, not by any qualitative difference in the epithelium. The lobule is enlarged and its ductules seen with greater ease than usual because of the increased quantity of clear connective tissue separating them (Fig. 4). A histological section through a normal lobule reveals numerous ductules surrounded by a small amount of intra-lobular connective tissue. A similar section through a hypertrophied lobule shows more numerous and larger ductules separated by a greater quantity of the characteristic pale connective tissue. A peri-canalicular fibro-adenoma is seen to be composed of an infinitely greater number of tubular ducts surrounded by this same supportive tissue. In fact, all gradations have been found between a normal lobule, a hypertrophied lobule and a frank fibro-adenoma. Some fibro-adenomata contain only the pale connective tissue found in the lobule and this is a strong argument in favour of the view that they are derived from a single lobule by a process of simple hypertrophy ; the absence of fat in their
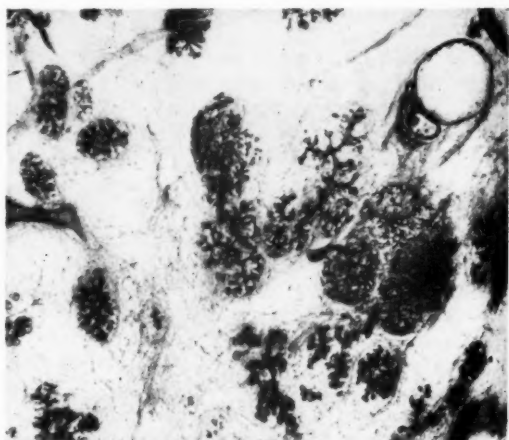
Fig. 4. On the left-hand side of the photograph relatively normal-sized lobules are present. There are hypertrophic lobules in the centre of the field and the largest is seen on the right-hand side.   × 10.

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substance is particularly significant in this respect. This explanation is deliberately simplified but is believed to be essentially correct, despite the great complexity of structure of many fibro-adenomata.

Lobular hypertrophy was present in all our specimens to a lesser or greater degree no matter whether the breast was clinically normal or not. Structures which would be generally regarded as fibro-adenomata were seen in most of our blocks. In view of the universal occurrence of hypertrophic lobules in one degree or another and the fact that they respond normally to physiological stimuli, there is considerable doubt as to whether this condition is truly pathological. The conclusion reached from the present investigation is that this is part of a natural physiological process and is only worthy of being considered " abnormal " in the sense that any excess oversteps the bounds of what is called " normal." A comparable example is afforded by an individual who is overweight or excessively tall.

There is no theoretical reason why simple lobular hypertrophy should be specifically linked with the origin of cancer. It is fully differentiated, functional tissue ; furthermore carcinoma has seldom been reported as arising in a fibro-adenoma which is the extreme degree of lobular hypertrophy.

Fibro-adenoma

The structure of fibro-adenoma must be discussed in greater detail because the thick section technique is particularly helpful in demonstrating its architecture. Few pathologists now believe that the condition is neoplastic ; indeed it would be unlikely that a lesion which can be found in most breasts, if carefully examined, were a tumour. Furthermore it responds to hormonal changes in a similar manner to the rest of the breast tissue ; it will, for instance, secrete milk during lactation. All evidence points to it being the most exaggerated form taken by the process of lobular hypertrophy.

Peri-canalicular and **intra-canalicular** are terms in common usage to describe the structure of fibro-adenoma. The first emphasizes that hypertrophic connective tissue surrounds ducts ; the second implies that fibrous tissue is actually invaginating ducts, producing polypoidal projections within them. It is thought that, in the second type, excessive growth of connective tissue immediately underneath the epithelium causes an infolding of the mucosa which produces the characteristic intra-canalicular pattern.

Doubt has been cast on this currently accepted explanation as a result of the present study. The accompanying illustrations show that the peri-canalicular type is composed of tubular ducts as is generally agreed (Fig. 5 (a)) ; however, the thick section technique moves *the emphasis* from the connective tissue to the duct system. Intra-canalicular fibro-adenomata are more difficult to comprehend because of their complexity. Some relatively simple examples have been seen in these sections which
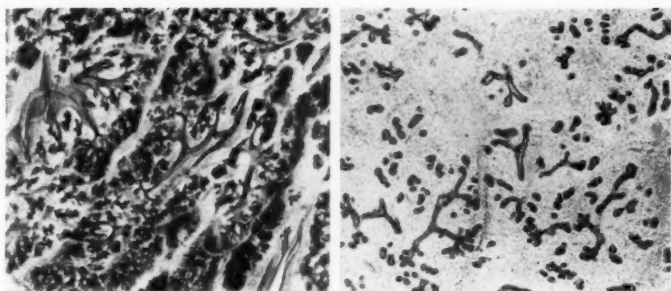
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Fig. 5.

(*a*) Thick section of a peri-canalicular fibro-adenoma. Tufts of blindly ending tubules arise from much larger ducts. Note the resemblance of the tufts to the pattern of a normal lobule. × 10.

(*b*) Thin section through a similar area to (*a*). Note the resemblance to normal ductules and the presence of intra-lobular type connective tissue around them. × 20.
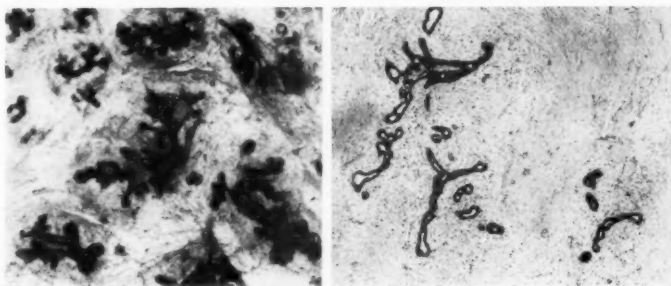

Fig. 6.

(*a*) Ductules are growing in a leaf-like pattern but the tips of the leaves have tubular extensions. × 10.

(*b*) A thin section through the laminar type ductule seen in (*a*). × 20.

provide a clue to the structure of the group as a whole. In Figure 6 (*a*) a ductule is seen which has developed in the form of a leaf; there is a lumen between the two walls of the laminar duct as is seen in a thin section prepared from the thick one (Fig. 6 (*b*)). If these laminar structures bifurcate during growth, producing more leaf-like projections from the surface, a fibro-adenoma of great complexity will result. In order to illustrate this difficult concept some plasticine models have been prepared and are shown in Figure 7 (*a*). In the first a duct has assumed the shape of a leaf; in the second two side branches have appeared; further branching has occurred in the third. The models were then embedded in gelatin and cut into slices with the result shown in Figure 7 (*b*). The gelatin gives the impression of invaginating the plasticine in an intra-canalicular manner,

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but in fact this effect is due to branching of the modelling substance, not to the pressure of the gelatin around it.

The terms **peri-canalicular** and **intra-canalicular** imply that the connective tissue determines the shape and configuration of the ducts. This idea, which springs from the belief that a fibro-adenoma is a connective tissue neoplasm, is not applied to any other tissue in the body.

(a)

(b)
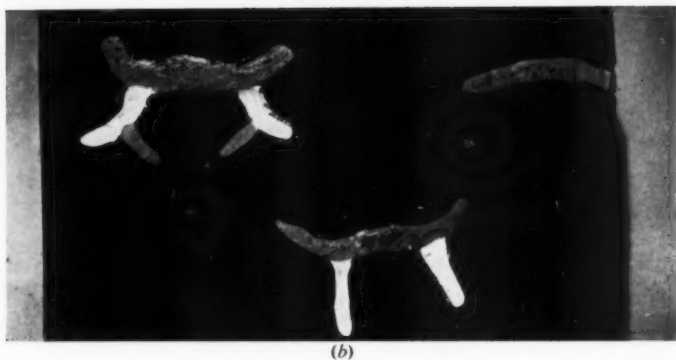
Fig. 7.

(a) Plasticine models to show the development of laminar ductules. On the right is a simple leaf-like formation. In the centre, branching (in light coloured plasticine) has occurred ; on the left the branches have subdivided further.

(b) The models were embedded in gelatin and a section cut across them. Note the typical intra-canalicular appearance.

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Fig. 8. Model of a tubular outgrowth (in white plasticine) from the face of a laminar duct.

It is not even applied to the other constituents of the breast tissue ; for instance, a normal lobule is not described as " peri-canalicular " implying that the pattern of the ductules is determined by the connective tissue. It is generally held that epithelium governs the structure of tissues ; ducts and glands evoke the surrounding connective tissue. Even supposing that in this one instance the converse is true, the behaviour of the connective tissue in a fibro-adenoma is strangely inconsistent. Figure 8 shows another model illustrating an event which is commonly seen ; a tubular outgrowth has developed from the side of a leaf-like duct. If the mass of connective tissue on the concave side of the leaf is compressing the duct into a laminar shape, it is strange that it should allow a tubular duct to grow straight out of the face it is alleged to be compressing. Furthermore, isolated fragments of laminar growth of ductules have been seen which are so small and are surrounded by so little connective tissue that it is hard to believe that the duct shape is determined by pressure.

If, however, the epithelium is credited with determining structure, as in other epithelial organs, these difficulties disappear. The ducts develop as they will, the connective tissue is evoked around them. It is suggested

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therefore, that the terms **peri-canalicular** and **intra-canalicular** be replaced
by **tubular** and **laminar,** both of which properly stress the epithelial
component.

Cystic change

Cysts of the breast are very common.   Dawson (1933) observed that
they arise by dilatation of the terminal portion of the lobular ductules
which can be readily seen in thick sections ; it is probable that the whole
ductule can also dilate in addition to its terminal expansion. A micro-cyst
is formed in the first instance, usually having a diameter of less than a
millimetre ; the entering ductule is almost always visible.   The cause is
unknown ; stenosis of the ducts or obstructing debris have not been
observed but it is possible that the staining technique used does not show
up debris. These small cysts are universally present and must be considered
physiological constituents of the breast.   Towards the menopause they
occur more frequently and are often accompanied by generalized enlarge-
ment of the ductules (Fig. 9). Sometimes they become quite large, either
by dilatation or by fusion with adjoining cysts. This type of cystic change
occurs in all varieties of breast tissue whether it be normal or the subject
of lobular hypertrophy.   There is no reason to suppose that cysts are
related to the latter condition aetiologically but both are so common that
they are commonly found together.

Eosinophilic cysts

The cyst which is diagnosed clinically is seldom of this simple nature
because micro-cysts do not often attain a diameter of more than a few
millimetres. One of sufficient size to cause a lump is usually an **eosinophilic**

Fig. 9.   A thick section to show micro-cysts.   Ductules of entry into the cysts can
be clearly seen.   × 10.
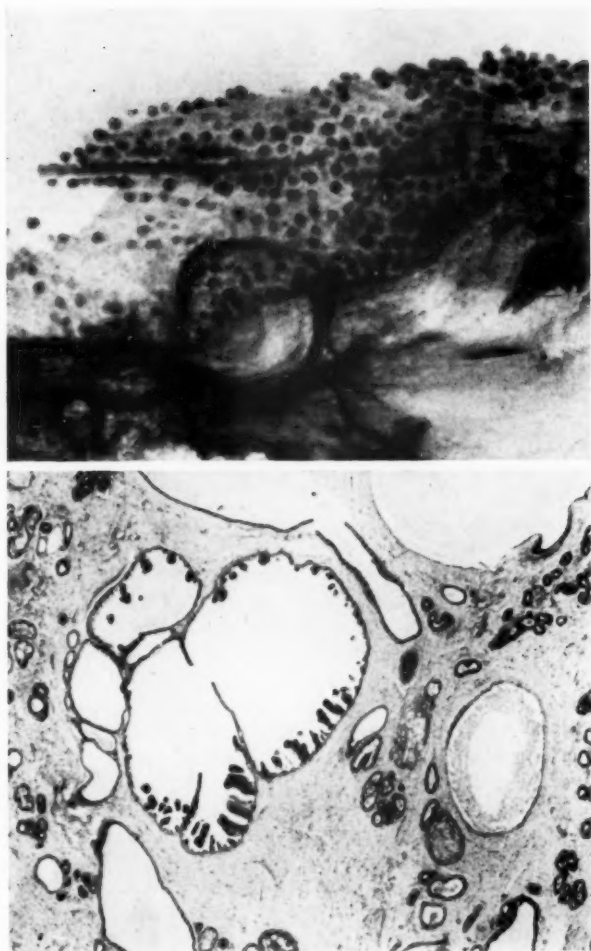
Fig. 10.
(a) Thick section of the side wall of a large eosinophilic cyst cut obliquely. Large numbers of sessile apocrine papillomata are present. × 20.
(b) Thin section of an apocrine cyst showing the small papillomata. × 20.

cyst. This remarkable structure is lined by eosinophilic epithelium which is usually thrown up into small punctate papillomata. It was at one time thought to be derived from sweat gland remnants within the breast, but this view is now universally rejected. Cysts of this type, which are some-

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times called **apocrine cysts**, are infrequent in the early years but in t ie fifth decade numbers of them can be found in most specimens of bre st tissue. In most cases they remain small and do not present clinical y, but they commonly grow over a centimetre in diameter and may atta n 4 to 5 centimetres.

Their nature remains in doubt ; Cheatle and Cutler (1931) thought th.it they were proliferative ; Dawson (1943) regarded them as being degenerative. They arise from the lobule, as do micro-cysts, but their exact origin is more obscure because an entering ductule is difficult to identify. When examined in serial sections a duct can always be found leading to a cyst, but on one occasion only has it been found possible to trace a point of entry into the cavity. We have found no convincing evidence that eosinophilic cysts usually have a patent duct connected with them. This may explain why it attains such a large size compared with the micro-cyst. It is believed, therefore, that deficient drainage causes the eosinophilic metaplasia and at the same time stimulates the formation of the large numbers of small papillomata which are so characteristic of this condition (Fig. 10). As a last stage even the eosinophilic lining may disappear, leaving behind a denuded cyst from which the fluid may ultimately be resorbed.

Eosinophilic changes also occur in the involutional phase following lactation and are manifestly part of a physiological process. The eosinophilic lobules are more dilated than those surrounding them, and it is suggested that duct obstruction is the cause of metaplasia in this case also. Apart from the characteristic metaplasia these cystic lobules have little resemblance to apocrine cysts.

Both micro-cysts and apocrine cysts must be considered to be physio-logical constituents of the breast. However, if they are excessive in number or occur in quantity at an early age it may be justified to regard them as abnormal. It has been suggested by a number of workers that cystic change is associated with the ultimate development of carcinoma. As small cysts are universal after a certain age, the suggested correlation can only be between an excessive degree of cyst formation and neoplasia. Dawson (1932) presented a closely reasoned argument against a direct relationship between apocrine cysts and carcinoma ; the evidence from the present study supports her view that cancer does not develop in these cysts. It is possible, however, that there is a common factor which may be aetiological for both, the most likely being diffuse papillomatosis.

Duct hyperplasia

Hyperplasia of ducts and ductules may cause the projection of masses of cells *within* the lumen, usually resulting in the formation of intra-duct or intra-cystic papillomata. In the present investigation only a few papillomata were found in the main ducts near the nipple, the type which causes clinical bleeding. It can be shown using thick sections that

papillomata usually occur in the terminal ductules ; they arise chiefly in the lobule (Fig. 11). They may be found at any age after puberty but are
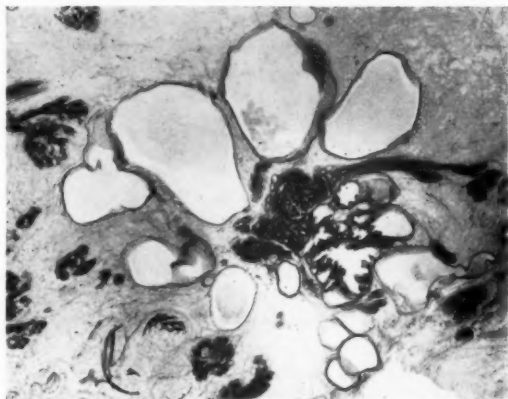

Fig. 11. An area of sclerosing adenosis containing an intra-cystic papilloma. × 10.

most common in the ten years centred on the clinical menopause. In senile breast tissue they are commonly found in remnants of lobular structures.

Early and latent carcinoma

One of the tasks attempted was to try to find carcinoma in its earliest, microscopic phase. It would be interesting to know how often early or latent carcinoma is present in breast tissue considered to be normal on clinical grounds ; it would also be interesting to locate the site of origin of breast cancer. From twenty-five cases, none of whom had clinical abnormality of the breast, all mammary tissue was removed at autopsy and was sectioned serially. On one occasion only was a suspicious lesion found. This resembled a small fibro-adenoma on thick section but the ducts were solid. It was removed from the section, embedded in paraffin and cut into thin sections (Fig. 12). It is composed of cords of cells of somewhat sinister appearance and many mitoses are present. Unfortunately, it is impossible to say whether it is malignant or not because it is non-invasive. If it were malignant, the fact that it is intra-lobular and not in one of the main ducts is of considerable interest.

Discussion

The thick section technique has several disadvantages, for instance the embedding process takes several weeks, but for this type of investigation it has two great assets. The first is three dimensional perception, which may not give more information than can be obtained with other methods, but it does present duct architecture in a new light. Perception in depth

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may suggest different interpretations from those currently accepted, as in the case of fibro-adenoma. Thick sections are also excellent for teaching purposes. The second advantage is that a far larger quantity of tissue can be examined than is practicable with paraffin sections, and furthermore it can be examined serially. A more comprehensive impression is therefore attained than is possible from the study of thin sections. This is particularly true of an organ such as the breast in which there is great variation from patient to patient and even from one segment to another in the same person. A biopsy from one part of the breast, therefore, gives no reliable information about the state of the remainder. Biopsies removed at different periods in the menstrual cycle are likewise of little value in obtaining information about cyclical breast changes. For similar reasons, it is difficult to decide what is normal and what abnormal. It is impossible, for instance, to estimate the normal density of lobules ; they may be concentrated or dispersed, but both extremes will be within physiological limits. It is not justified to call an area of high density " adenosis " ; this term should be reserved for qualitatively abnormal lobules.

Benign aberrations of breast anatomy have been classified under three main headings, **lobular hypertrophy, cystic change** and **duct hyperplasia**. There is no evidence to suggest that they are related aetiologically though it is probable that duct hyperplasia can cause the formation of apocrine cysts by obstructing the ductular lumen. Variation, both quantitative and
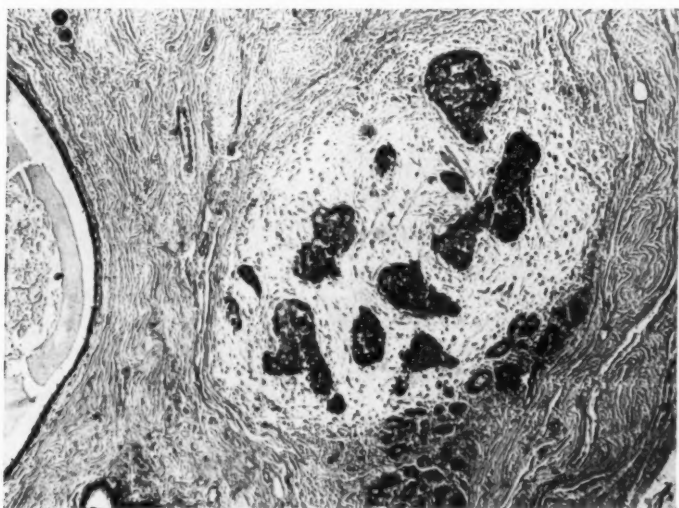
Fig. 12. Thin section prepared from a thick section which showed a suspicious lesion. Note the intra-lobular connective tissue surrounding the solid cords of cells of sinister appearance. Normal lobular ductules are seen in the lower half of the photograph. × 20.

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qualitative, in all three is so great that the boundaries of normality are broad and hazy; minor degrees are probably universal. The three main types of abnormality are derived from the lobular ductules which have the following characteristics. They arise from the main ducts at puberty; they proliferate during pregnancy and form milk secreting alveoli at the commencement of lactation. At the menopause they disappear leaving the main ducts intact. They are always associated with characteristic, pale connective tissue. The duct system of a fibro-adenoma fulfils most of these criteria which strongly suggests that it is formed as a result of hypertrophy of the lobular ductules. It is difficult to draw the boundary between a normal and hypertrophic lobule, minor degrees of hypertrophy are universal. Should the extreme limit, fibro-adenoma, also be considered to be a normal constituent of the breast ?

The great anatomical variation necessarily implies clinical variation as well. Small aggregations of quite normal lobules may be palpable in a thin person, whereas large cysts may be present in a fat individual and not be detectable clinically. A mild degree of lobular hypertrophy will be palpable in a thin patient but not in someone who has more adipose tissue. Here again, therefore, it is impossible to define normality and many patients with clinically lumpy breasts will have perfectly physiological breast tissue.

The changes which occur with time make it possible to estimate the age of a patient from inspection of a histological section. In young women lobular hypertrophy is often present; multiple fibro-adenomata may be formed if the change is excessive. In the fourth decade micro-cysts and lobules of irregular appearance become common. In the fifth decade apocrine cysts increase in numbers and size. At the period of the menopause itself, papillomata appear. Variation in this time sequence is very great.

Post-menopausal atrophy causes the dissolution of the lobules leaving the subsidiary ducts truncated as seen in Figure 1. Variation is again great, so much so that menopausal involution may never take place. Different segments of the breast may also show remarkably dissimilar degrees of atrophy. Perhaps the most important consequence of the atrophy of the menopausal era is that all structures derived from the lobule disappear including fibro-adenomata, cysts and papillomata. This makes the diagnosis of a lump in the breast of a patient over fifty-five years relatively simple, for about 90 per cent. of them are malignant. The difference in response between the major ducts and lobular ductules at the menopause is theoretically important. It implies that the epithelium of the intra-lobular ductules is more sensitive to certain hormonal changes than that of the main ducts. A corollary of this is that a carcinoma arising from ductular epithelium would also be sensitive to these changes. This is important in relation to endocrine ablation operations for the

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treatment of cancer. It would, therefore, be of great interest to know whether carcinoma in the elderly patient arises in the ducts, which are relatively unaffected by involution, or in the many areas of lobular remnants which are commonly found. In these areas also, cysts, fibro-adenomata, and papillomata may be present but they are small and seldom manifest themselves clinically.

The site of origin of cancer in the breast is still unknown. The gradation from simple papilloma through intra-duct carcinoma to frank scirrhous carcinoma is frequently seen in serial sections and is so striking that many pathologists have agreed with Dawson (1933) that the hyperplastic ductule is the source of malignancy. Papillomata of the large bowel, the bladder and larynx are all deemed to be pre-malignant or at least to indicate increased malignant potential in the entire epithelium of the organ concerned. It is interesting that there is a time lag of about fifteen years in most of these organs between the development of papillomata and the onset of carcinoma. The time factor is most marked in the condition of familial polyposis of the colon ; approximately 40 per cent. of those developing polypi also produce single or multiple carcinomata. The papillomata develop in the second decade, cancer occurs in the fourth.

Papillomata of the breast only occur commonly over the age of fifty years and by analogy, therefore, cancer would be expected to occur frequently in the seventh decade. But there is a crucial difference here between the breast and other organs because at about the age of fifty-five years, atrophy of all lobular derivatives occurs, including most papillomata. A woman who develops duct hyperplasia after the age of forty, a fairly common event, may therefore run no greater risk of cancer than her sister who has no such changes. This argument must be qualified by mentioning once more the great variation which is such a characteristic of breast anatomy and pathology.

Some women, however, develop extensive papillomatosis in their youth, sometimes as early as twenty-five years ; it might be expected that they would run a grave risk of cancer developing by the age of forty-five years. Post-menopausal involution would not come early enough to afford them protection. If any benign lesion of the breast is suspect of pre-malignancy on theoretical grounds, it is this variety of papillomatosis occurring in young women. It would, therefore, be most interesting to observe over a long period a series of patients in whom it was discovered early in life. It is possible that hereditary traits would be revealed, definite risks of malignancy evaluated and prophylactic measures devised. These views are, of course, purely hypothetical and are based on circumstantial evidence only. It is interesting to speculate, however, that the axe which falls at the menopause may well save many women from cancer inasmuch as it causes the atrophy of an epithelium which has already demonstrated its neoplastic potential by producing multiple papillomata.

I would like to thank my colleague Mr. J. L. Hayward for his collaboration in this investigation; also Mr. H. J. B. Atkins, Director of the Department of Surgery at Guy's Hospital, for allowing me the use of the facilities of his department and for his constant help and encouragement. I am greatly indebted to Mr. T. R. Nichols and his staff for help in the preparation of the sections.

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APPOINTMENT OF FELLOWS AND MEMBERS TO CONSULTANT POSTS

P. TIMMIS, F.R.C.S.	E.N.T. Surgeon to Luton and Hitchin Group of Hospitals.
J. E. A. O'CONNELL, M.S., F.R.C.S.	Neurosurgeon to Luton and Dunstable Hospital.
M. C. D'ALMEIDA, F.F.A.R.C.S.	Professor of Anaesthesiology to Pontifical Catholic University, Rio de Janeiro.
C. HAVARD, M.CH., F.R.C.S.	Consultant General Surgeon to Bridgend General Hospital.
L. H. PIMM, F.R.C.S.	Consultant Orthopaedic Surgeon to Ipswich and East Suffolk Hospital Group.
P. G. COLLINS, M.CH., F.R.C.S.	Visiting Consultant Surgeon to Jervis Street Hospital, Dublin.
S. S. ANAND, F.R.C.S.	Honorary Surgeon to the President of the Republic of India.
G. H. WADDINGTON, M.R.C.S.	Consultant Radiologist to Lancaster and Kendal and Lancaster Moor Groups of Hospitals.
L. R. McLAREN, F.R.C.S.	Consultant Plastic Surgeon to South Manchester Group of Hospitals.
T. L. BRADBEER, F.R.C.S.	Consultant E.N.T. Surgeon to the Devon and Exeter Clinical Area.
D. G. LYON, F.D.S.R.C.S.	Honorary Consultant to the University of Bristol.
MISS I. D. R. GREGORY, F.R.C.S.	Ophthalmologist to Royal London Homoeopathic Hospital.
R. W. McNABB, M.R.C.S.	Radiologist to Watford, St. Albans City, Napsbury & Harperbury Hospitals.
K. W. G. HEATHFIELD, M.D., M.R.C.S.	Neurologist to Barnet General Hospital.
T. FAZLEABAS, F.R.C.S.	E.N.T. Surgeon to the Badulla General Hospital, Ceylon.
H. P. COOK, F.D.S.R.C.S.	Consultant Dental Surgeon to Middlesex Hospital and Royal Dental Hospital.

The Editor is always glad to receive details of new appointments obtained by Fellows and Members, either through the Hospital Boards or direct.

ANATOMICAL MUSEUM

THE SPECIAL DISPLAY for the month of December will consist of John Hunter's odontological preparations together with the original manuscript of his book *Natural History of the Human Teeth,* published in 1771.

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HOWARD GRAY MEMORIAL LIBRARY

THE OPENING CEREMONY of the Howard Gray Memorial Library took place on Thursday, 24th September 1959. A large group of friends of the Gray family and British surgeons, who had enjoyed the hospitality and friendship of the late Howard Gray while they worked at or visited the Mayo Clinic, gathered in the Webb-Johnson Hall.

Howard Gray

The President, preceded by the Mace, accompanied by Mrs. Gray and Mr. Howard Gray, Jnr., and followed by Lady Webb-Johnson, the two Vice-Presidents and members of Council, processed to the dais. The President opened the proceedings with the following words :

" Mrs. Howard Gray, Ladies and Gentlemen : It is a great honour for me, for which I feel very proud, to welcome you, Ma'am, and your son and all this audience here to-day to carry out this very delightful ceremony. I feel in some ways, as I say, proud to be called upon to do it, but in some ways humble because I know that many of you in this room knew Howard Gray better than I did. I had the privilege of meeting him when he was here in 1951, both at St. Bartholomew's and in this College, but I know that most of you met him in his own home and that was so much more than I did. This is a gathering of friends : I hope you won't feel that we are making it too formal, but I feel that it is important that we should make it a real College occasion because we wish to show honour to his memory as well as to Mrs. Gray and Howard. This is almost a family gathering, and like many family gatherings it has its mixed feelings, with some sadness, particularly on this occasion. Yet on our part, and I hope on the part of you all, this one has the satisfaction that we are having an opportunity of paying a real tribute to the memory of a very

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great man. There is the old saying that if you want to give a man a bouquet it is best to do so while he can still smell the flowers : but when that is impossible then we can try to do the next best thing and bring his dearest and nearest to us so that they can perhaps sense the fragrance of our tribute.

" This is a day to which we have looked forward for a very long time, and, in a way, when you have looked forward to something for a long time and it happens you feel well, this is just it. I think it would be worth while spending a very few minutes pondering about what we really are doing. You might say that we are here to honour a very distinguished surgeon, but there is much more to it than that. Already he had been honoured : his name is on the College Roll because he was a Moynihan Lecturer, and you will find his name in our College books. I am glad to say that Mrs. Gray, at this moment, is sitting in a chair which has his name on the back of it. So his name is remembered in that way too. The chair was given to the College by old friends—his first assistant, Walter Mackenzie, and Dr. Willox of Edmonton—so that really we have already some memorial to him as a distinguished surgeon. You might say that we have come here because his life ended in a way which would bring feelings of sympathy and sorrow to the hardest-hearted person, and that that in itself would be sufficient to make us gather here ; but, you know, neither of those things is the really important reason for it, which is that Howdie was the head of a family which was outstanding for their great kindness to all those who came to the Clinic. They not only opened their hearts to them but they opened their home to them, and they thus made friendships which have lasted and grown as the years have gone by, and I have never met anybody who has had so many folk enquiring about them as they have. As I told Mrs. Gray herself, in the last few months I have had so many people asking us to tell them when this memorial was going to be inaugurated. They are a family with a host of friends, and real friends : and I know that, although it is pleasant that we have a fair number of you here to-day, this is only a fraction of those who are thinking about what we are doing at the present time. I have a letter here from Donald

Mrs. Gray opening the door of the Howard Gray Memorial Library with the President and Mr. A. Dickson Wright (Vice-President).

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Balfour and another from Jim Priestley, and you yourselves know quite well that there are people, not only in the Clinic but all over the world, who are their friends and who know about this occasion and who are thinking about us now.

" One final word and then I must stop, for I have no intention of speaking for long, but I can't help trying to put some of my thoughts into words. It may be in the minds of some of you that perhaps it may be almost redundant to try to make any local memorial to a person whose character and whose gifts were so outstanding and one might almost say so super-human. It might be argued that to have something which is just in the realm of material and temporal things isn't really needed to commemorate a person who moved in a realm of spiritual and eternal things ; but I think it is necessary sometimes for men to have something they can see to make them feel that they are doing something, the best they can, as a tribute to their friend. So that we are glad to have you, Wint, here and you, Howdie, to be with us at the time when we inaugurate this Memorial Library.

" Now we owe a lot, as regards the actual Library itself, to the activity, the energy and the drive of Mr. Dickson Wright, and I would like him just to tell us in a few words how it came about that this Library has been collected, which you will see in a few minutes. We are going from here upstairs to the Library ; and I will ask Wint to open it and then afterwards we can all meet and talk. But first perhaps Mr. Dickson Wright would kindly give us a brief account of how this Memorial came into being."

Mr. Dickson Wright then spoke as follows :

" Mr. President, Mrs. Howard Gray, Howard Gray, Ladies and Gentlemen : the President has put in very fine words our feelings about Howard Gray and, just as he said, what we felt when that awful news reached England four years ago about his tragic end. I don't think any piece of news set more telephone bells ringing in this country as when that word came of the end of Howard Gray. When over there I had a chance to look in his visitors' book, and it was quite an amazing document ; it was almost like our Medical Register, and their names were legion, and the remarks were very kind. And I felt that there must be many who have particular feeling towards the Gray family and would like it to take some tangible expression in this country. So I wrote around and had an immediate and most generous response from more than are here to-day, for some are in distant parts and cannot be with us. Everybody here to-day has played a part in the making of this Library. When, with some trepidation, I asked the President if he would agree to my suggestion of a Library within the precincts of the College, I was delighted when he agreed. And all through the preliminaries to the final time, he has been everything that could be hoped for, helping in every way and encouraging me in it. And so it came into being and when it was all completed, just on the verge of the opening, in a very kind delicate way the Mayo Clinic suddenly seemed to wake up. I think they held back any remark until we had completed our arrangements and they knew all was ready. Then came kindly messages from Chuck Mayo asking me to buy a piece of furniture on behalf of the Mayo Clinic to put in the Library. And then another letter and telegram came from Dr. Hench who, to me, is the physician in the Mayo Clinic comparable to Howard Gray as a surgeon, and one of ability and personality and kindness of character ; he also asked me to purchase a piece of furniture. These are gifts on top of what we had done, as they wished the Library to have some visible object to show their interest for all time, and really Hench's letter was such as would have made a speech for this occasion. He runs over all the virtues of Howdie Gray in the most wonderful words. I won't read it all out, but it is really a remarkable letter. He spoke of his infectious zest for living, how he did everything with enthusiasm and seemed to enjoy every minute of his life, wherever he was, in hospital or at his Church, or at home with his family, or

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Fig. 3a

Fig. 3b

Two aspects of the Howard Gray Memorial Library. Fig. 3a shows the old President's desk on which rests the Brown Bible presented by Mrs. Howard Gray and her family.

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with friends at some place of entertainment. We all know the strong streak of religious beliefs in him, we saw it in his family and his whole outlook on life, but it never interfered with his enjoyment of others and enjoyment of himself. I think that when Rupert Brooke was going to Gallipoli he wrote these lines : " If I should die, think only this of me, That there's some corner of a foreign field that is forever England." And now a little place in England is for ever dedicated to Howard Gray. I feel that having done that we, who were the recipients of his kindness, who received from him surgical instruction comparable to none, and who received from him instruction in behaviour to patients, and outlook on colleagues—there's been an advantage to us all—we feel now that we have shown some appreciation of what he did for us. I often think of him in the terms that were used by Henley, the poet, when speaking of Lord Lister. Henley was a very fine figure of a man, red hair, very tall, very strong, a magnificent physical specimen : a great contrast to his rather delicate friend, Robert Louis Stevenson. Stevenson always admired Henley for his wonderful strength and appearance, but he was smitten with tuberculosis and lost a leg ; and then the tuberculosis appeared in his other leg and they wanted to amputate his leg in Gloucester. But he went up to Edinburgh and placed himself in the hands of Lord Lister, and for two years Lord Lister worked upon his case. He performed many operations, did all the dressings himself and saved Henley's leg so that he walked out of hospital on one good leg. And he described Lister in words which I think fit Howard Gray like a glove :

   ' His face at once benignant, proud, and shy,
   His faultless patience, his unyielding will,
   Beautiful gentleness and splendid skill,
   Innumerable gratitudes reply.
   His wise rare smile was sweet with certainties
   And seemed in all his patients to compel
   Such love and faith as failure could not quell.'

" These words, written about Lister, seem to fit Howard Gray in quite a remarkable way. We are sorry he didn't live on with us and get all the honours that were to come to him from this College, as they surely would, and from this country, where he was loved more than any other American surgeon.

" One last word : Mrs. Gray and her family and others wanted to do something, and presented the Bible which is part of the Library. It is a large American family Bible which was printed a hundred years ago. A Brown Bible, with quite a historical binding. It is a very, very fine volume and she sent that over to us with the good wishes from herself and her family. That is the centre piece of the Library, it is on a desk and one can read it with great ease. I spent a quarter of an hour reading it yesterday very comfortably indeed, on the death of Hezekiah, who was granted another fifteen years of life. We only regret that we didn't have Howard Gray with us for another fifteen years.

" I am going to ask Mrs. Gray to open the door of the Library for us in a few minutes, but I think that she would like to say something down here before we go upstairs."

Mrs. Gray then rose and addressed the assembled company in the following words :

" This is a very happy and a very proud day for the Gray family, for Howdie my son who is here with us, and for our daughter and her husband, who would so loved to have been here but couldn't because the birth of a little baby a few days ago prevented it, and certainly it is for Mrs. Howard Gray. I think you will understand when I say that from a heart way this is a very full to overflowing day. Howdie would have loved this room you will see, and been deeply pleased with it. But, you know, because our family think that the three most important things that one can possess are one's faith, one's family and one's friends, that he

would have been happiest over this evidence of their affection for him. It is a very great honour, I know, and it is a wonderful tribute to him, but do you know what I think would have carried great weight with him ? Its usefulness, because already have seen some of the young men in the College using it, and that is good. And so to all of you who have made this possible, thank you very much. Thank you, and bless you for giving Howdie a second home which is on British soil, from which the warm understandings between British and American surgeons and all over the world can be carried on and secured. And that's from my heart."

The assembled company then walked in procession to see the Memorial Library, which is on the first floor of the Nuffield College.

GIFTS TO THE LIBRARY

A SUPERB COPY of the first collected edition of Ambroise Paré's *Works* in French has been most generously presented to the College Library by Dr. E. G. Greville, M.C., M.R.C.S. This handsome book, a folio of nearly 1,000 pages, was published in Paris by Gabriel Buon in 1575. It contains very fine woodcut illustrations, over which Paré is known to have laboured with loving care ; there is also a woodcut portrait of the author, who was now sixty-five years old. Janet Doe in her *Bibliography of Paré* points out that the book " the darling of Paré's heart, was at once the culmination of his hopes to place surgery in its rightful place among the arts, to put the understanding of it within the reach of the humblest barber-surgeon, and to confound his own enemies. ... It became, from its first appearance, the surgical code of its era. It was the first real surgical treatise which brought in the new experimental spirit." Dr. Greville's copy, which is in splendidly fresh condition, has a beautiful contemporary binding of white vellum, stamped on each cover with a large formal gilt ornament.

Dr. Greville has also presented a copy of the collected Works of Paré's most distinguished pupil Jacques Guillemeau, published in Paris in 1612, which contains many very fine engravings of surgical instruments. This gift is an important addition to the fairly large collection of Guillemeau's books already in the library, which are second in interest only to those of Paré in the history of surgery in France.

Another rare and interesting book has been generously presented by Mr. Philip Wiles, F.R.C.S. : *The Order of the Hospitals of King Henry the viiith and King Edward the vith . . . by the Mayor of London.* 1557.

This is concerned with the statutes of the four Royal Hospitals, really two hospitals (St. Bartholomew's and St. Thomas's), a school (Christ's Hospital) and a reformatory (Bridewell) ; after the suppression of the monastic foundations they were re-established by royal charters and put under the charge of the Lord Mayor. The late Sir D'Arcy Power proved that this book is not what it appears, a contemporary document, but a late seventeenth-century publication, reproducing a manuscript of 1557. It was probably put out by the famous Samuel Pepys, who was a governor of Christ's Hospital, about 1690. Very few copies of this unusual work survive, and the College is indeed fortunate in obtaining this copy through Mr. Wiles's generosity.

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CONFERMENT OF HONORARY FELLOWSHIP OF THE ROYA COLLEGE OF SURGEONS OF EDINBURGH UPON SIR JAMES PATERSON ROSS AND SIR CLEMENT PRICE THOMAS.

ON THE AFTERNOON of Thursday 23rd July 1959, a ceremony was held in the Royal College of Surgeons of Edinburgh for the purpose of admitting to Honorary Fellowship of that College Wilder Graves Penfield, Esq., O.M., C.M.G., M.D., D.Sc., Hon. F.R.C.S.Eng., F.R.C.S.C., Newell W. Philpott, Esq., M.D., F.R.C.S.C., F.A.C.S., Sir James Paterson Ross, K.C.V.O., M.S., P.R.C.S.Eng., Hon. F.A.C.S., Hon. F.R.A.C.S., Sir Clement Price Thomas, K.C.V.O., M.D., F.R.C.S.Eng., Hon. F.A.C.S., Hon. F.R.C.S.I. and Loyal Davis, Esq., M.D., Ph.D., D.Sc., Hon. F.R.C.S.Eng.

Preceded by the Mace, the President, Office-Bearers and Council with the new Honorary Fellows and their Sponsors entered the Hall in procession. After the reading of the College prayer by the Chaplain, the Very Reverend Dr. Charles Warr, Dean of the Thistle and Chapel Royal, the President constituted the Meeting in these words :

" My Council and I have convened this Extraordinary Meeting of Fellows for a special purpose, and one which gives us rare delight.

" From time to time it is our custom to admit to Honorary Fellowship those who have well served the craft of surgery and the wellbeing of their fellow-men. Throughout the years we have guarded this honour jealously since it was first bestowed 300 years ago. Our Roll of Honour contains the names of Surgery's most illustrious sons, both in this country, in Europe and in the great New World beyond the Atlantic.

" These names we have held in high esteem in this College. To-day it is my privilege to welcome others of like eminence, like distinction and like friendliness, whom it is our delight to honour with the highest distinction that this ancient Corporation is able to bestow."

The President then called upon the Sponsors to present the new Honorary Fellows.

Sir James Paterson Ross was presented by *James Johnston Mason Brown, Esq., O.B.E., F.R.C.S.Ed.,* who spoke thus :

" Mr. President : I have the honour to present to you for admission to the Honorary Fellowship Sir James Paterson Ross, President of the Royal College of Surgeons of England, Professor of Surgery in the University of London and Director of the Surgical Clinical Unit at St. Bartholomew's Hospital.

" An undergraduate at the beginning of the First World War, he served as a sergeant in the Territorial Royal Army Medical Corps, but on qualifying M.R.C.S. and L.R.C.P. in 1917 he transferred to the Senior Service as a Surgeon Lieutenant, an early association with the Royal Navy which he maintains to-day as Consulting Surgeon.

" On his return he graduated M.B., B.S. with distinction in surgery and forensic medicine and was awarded the University Gold Medal ; two years later he became a Fellow of the Royal College of Surgeons of England. After junior appointments, a period as Associate in Surgery in the Neurological Clinic of the Peter Bent Brigham Hospital in Boston preceded his return to ' Bart's ' to work with his chief, Professor George Gask, a pioneer in the development of whole-time professorial clinical units. Gask's wisdom in forming the unit was equalled

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CONFERMENT OF HONORARY FELLOWSHIPS

(Reproduced by courtesy of " The Scotsman")

Professor John Bruce, the President of the Royal College of Surgeons of Edinburgh, welcoming Professor Sir James Paterson Ross to the Honorary Fellowship of that College.

by the selection of his assistant, for, as his successor, Sir James has done much to foster the intimate association between University and Teaching Hospital that is necessary for the advancement of medical knowledge. It was probably also from his chief that Sir James acquired his interest in the surgery of the sympathetic nervous system to which he has made so many contributions.

" Time does not permit a recital of all the honours conferred upon him, both in this country and abroad. Jacksonian Prizeman and three times a Hunterian Professor of his own College, he is an Honorary Fellow of the American and Royal Australasian Colleges of Surgeons, a member of the American Surgical Association and of the Philadelphia Academy of Surgeons, and an Honorary Doctor of Laws of the University of Glasgow. His services to his King were acknowledged when he was made a Knight Commander of the Royal Victorian Order, and that service continues as Surgeon to Her Majesty The Queen. In 1957 his qualifications as an ambassador of all that is best in British surgery were recognized by his appointment as Sims Commonwealth Travelling Professor. He is President of the Association of Surgeons of Great Britain and Ireland and Chairman of the Editorial Committee of the *British Journal of Surgery*. His election in 1957 by that most exacting of all tribunals—one composed of his immediate colleagues—to the Presidency of the Royal College of Surgeons of England is evidence of their regard for his integrity and wise counsel.

" Mr. President, it is not because he is President of our sister College or because of the many honours and distinctions that are already his that we do Sir James honour to-day ; it is his personal qualities of mind and heart that

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have won our admiration. He has the patience that can conquer anything and the great mind that knows the power of gentleness. It has been said that ' he that is a master must serve,' and I venture to say that no previous President has given greater service to his College or has taken such an active interest in the younger surgeons whose names he never forgets.

" He knew the difficulties of the early days of a surgical career, for junior hospital appointments have never given security, and full-time lectureships and professorships did not offer the glittering monetary rewards of private surgical practice. I am certain that Sir James could not have accomplished half as much without the help, the encouragement and forbearance of Lady Paterson Ross, whom we are delighted to welcome to-day. With such an example it is not surprising that both their sons should have chosen surgery for their life's work.

" Though born in London Sir James is of pure Scottish descent, for his parents were of true Highland stock, and with such heredity his success was inevitable ! In the words of Barrie : " A young Scotsman of your ability let loose upon the world, what could he not do? It's almost appalling to think of ; especially if he went among the English."

" Mr. President, in adding the name of Sir James Paterson Ross to our Roll of Honour we honour ourselves, and it is my great privilege, in the name of the Fellows, to ask you to confer upon him the Honorary Fellowship of the Royal College of Surgeons of Edinburgh."

Sir Clement Price Thomas was presented by *Robert Smillie Barclay, Esq., M.D., F.R.C.S.Ed.,* who spoke as follows :

Mr. President: It is my happy privilege to present Sir Clement Price Thomas for admission as an Honorary Fellow of this College.

" Sir Clement, or C.P. as he is referred to most affectionately by his colleagues both young and old, has within recent months retired from his various hospital appointments which included Consultant Surgeon to Westminster and Brompton Hospitals—posts which he filled with distinction.

" Trained as general surgeon, it was in the field of thoracic surgery that he was to achieve international fame in continuing and enhancing the pioneer work of his fellow-countrymen, Morriston Davies and Tudor Edwards. It is well to remember that this early work was carried out at a time when the practice of thoracic surgery could be described as an uphill fight, when anaesthesia left much to be desired and modern antibiotics were yet to be discovered.

"A master technician, as evidenced by his results especially in the surgery of the bronchial tree, he followed closely the achievement of his colleague and friend, Clarence Crafoord of Stockholm, in performing the first operation in this country for coarctation of the aorta, thus blazing the trail in cardiac surgery. I can well remember him, at a meeting of the Society of Thoracic Surgeons, recounting with disarming humour so characteristically directed against himself, that the anastomosis on release of the clamps took on the appearance of a watering-can !

" Throughout his brilliant career, many honours and distinctions have been conferred upon him. His late Majesty created him a Knight Commander of the Royal Victorian Order, he is a Past President of the Association of Surgeons of Great Britain, a Past President of the Society of Thoracic Surgeons of Great Britain and Ireland and of the Royal Society of Medicine. It is very fitting indeed, that his country has honoured its distinguished son in electing him President of the Welsh National School of Medicine.

" The name ' Welsh Wizard ' will immediately bring to the minds of many of you Lloyd George ; to a few, no doubt, Dai Rees, our Ryder Cup Golf Captain but most surgeons and especially thoracic surgeons will agree that it fittingly describes Sir Clement.

(Reproduced by courtesy of " The Scotsman")

Sir Clement Price Thomas signing the Roll of Honorary Fellows of the Royal College of Surgeons of Edinburgh.

" I should like to say a few words about Sir Clement as a man. Despite of all his distinctions, he has retained the delightful qualities of modesty and kindliness which have endeared him to his many friends and patients in this country and abroad. During the past fifteen years I have had the pleasure and the privilege of meeting him in the operating theatre and socially, and I know that I speak for many surgeons in these islands and far-off lands when I say that they owe Sir Clement a debt of gratitude not only for teaching them the art of surgery but also for the shining example he has been to them in his private life. He, in turn, must feel justly proud of the work of many of his pupils.

" I am deeply conscious, Mr. President, of the honour you have done me in inviting me to present to you Sir Clement Price Thomas. I now have much pleasure in asking you to confer on him the Honorary Fellowship, the highest honour that this College can bestow."

After each citation the new Honorary Fellow was gowned. He was then invited to subscribe to the Declaration of Entrants and was presented with the diploma by the President.

IMPERIAL CANCER RESEARCH FUND

Mr. A. B. L. CLARKE, O.B.E., has been appointed Secretary of the Imperial Cancer Research Fund with effect from the 24th November 1959, and his office is in the Fund's premises at No. 49, Lincoln's Inn Fields. Mr. Clarke was formerly in the Malayan Civil Service and held the post of State Financial Officer in Penang.

Mr. Kennedy Cassels, who has been the Fund's Secretary for the past twenty-one years, will now devote the whole of his time to the affairs of the Royal College of Surgeons.

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SIR ARTHUR SIMS COMMONWEALTH
TRAVELLING PROFESSORSHIP

THE PROFESSORSHIP WAS founded and endowed in 1946 by Sir Arthur Sims, a New Zealand industrialist with business interests in New Zealand, Australia and England, acting in close consultation with Lord Webb-Johnson, who was President of this College at that time.

The objects are the establishment of closer links between scientific workers in the Dominions and in the older seats of learning and centres of research ; the benefit thereby of the people of all nations ; and a contribution to Imperial unity.

The Professor is required to travel from the country where he or she is ordinarily resident to Great Britain, or to Australia and New Zealand, and to any other Dominion of the British Commonwealth, for the purpose of assisting in the advancement of medical science by lecturing, teaching or engaging in research. The duty is ambassadorial as well as academic.

The appointment is made by the Council of the Royal College of Surgeons of England on the recommendation of the Advisory Board which consists of :

The President of the Royal College of Surgeons of England (*Chairman*).

The President of the Royal College of Physicians of London.

The President of the Royal Australasian College of Physicians.

The President of the Royal Australasian College of Surgeons.

The President of the Royal College of Physicians and Surgeons of Canada.

The President of the College of Physicians, Surgeons and Gynaecologists of South Africa.

The Secretary of the Royal College of Surgeons of England acts as Secretary of the Advisory Board.

The duties (i.e., the countries to be visited) and the emolument are stated at the time of the appointment, which is normally made in March prior to the year of office.

The time of year at which the tour is made, its exact duration (which is usually about three to six months) and the centres to be visited within the stipulated countries are determined by each Professor in accordance with his own interests, aptitude and individual commitments. His itinerary is usually arranged for him by the appropriate Royal College in the country of his tour, which also gives him invaluable help in organizing visits to hospitals and other institutions, in booking accommodation and travelling tickets, and many other matters. Annual or other important meetings are sometimes arranged to coincide with Sims Professors' visits.

Newly appointed professors, when planning their tours, get much useful guidance from the reports of their predecessors, copies of which are made available for their use. Frequently too they get the benefit of personal

advice, not only from previous professors, but also from Sir Arthur Sims himself, for all meet together at an annual social gathering.

The following list of the professors to date shows that the Advisory Board maintains a balance and rotation between Physicians and Surgeons, and between the countries of origin of the professors and the countries which they visit :

1948	SIR HUGH CAIRNS, U.K.	Australia and New Zealand. Athens. Africa (Makerere, Salisbury, Johannesburg, Pretoria, Durban, Port Elizabeth, Cape Town, Stellenbosch).
1949	PROF. G. W. PICKERING, U.K.	Australia and New Zealand. South Africa and East Africa (Kampala, Johannesburg, Pretoria, Cape Town, Stellenbosch, Bulawayo, Salisbury).
1950	SIR REGINALD WATSON-JONES, U.K.	Canada, Singapore, Australia and New Zealand. Rhodesia and Union of South Africa (Uganda, Pretoria, Cape Town and Johannesburg).
1951	PROF. D. M. DUNLOP, U.K.	Colombo, New Zealand, Australia, Singapore.
1952	SIR CHARLES DODDS, U.K.	Colombo, Malaya, Australia, New Zealand, and Canada (Vancouver, Montreal, Toronto).
1953	PROF. H. R. DEW, Australia	British Isles.
1954	SIR JAMES LEARMONTH, U.K.	Australia, Tasmania, New Zealand, Canada (Vancouver, Winnipeg, Toronto, Montreal).
1955	PROF. R. I. HARRIS, Canada	Australia, Tasmania, New Zealand, England and Scotland.
	DR. DONALD HUNTER, U.K.	Canada and Rhodesia.
1956	SIR GEOFFREY KEYNES, U.K.	West Africa, South Africa (Johannesburg Pretoria, Cape Town, Durban, East London), Southern Rhodesia, East Africa, Uganda, Canada.
	SIR LIONEL WHITBY, U.K.	Australia and New Zealand.
1957	SIR JAMES PATERSON ROSS, U.K.	Australia and New Zealand.
	PROF. W. MELVILLE ARNOTT, U.K.	Canada and Africa.
1958	PROF. M. L. ROSENHEIM, U.K.	Australia and New Zealand.
	PROF. R. M. JANES, Canada	Africa.
	MR. B. K. RANK, Australia	Canada.
1959	MR. W. GISSANE, U.K.	Australia and New Zealand.
	PROF. E. J. WAYNE, U.K.	Canada.
	PROF. R. B. KERR, Canada	Parts of Africa.
1960	PROF. J. MCMICHAEL, U.K.	Australia and New Zealand.
	MR. G. D. ROBB, New Zealand	Britain and parts of Africa.

BINDING OF THE ANNALS

BINDING CASES ARE not provided for completed volumes of the ANNALS but the Editor can recommend the firm of Lovett, Bookbinders, 86, Plashet Grove, London, E.6, who will undertake the binding in buckram or leather to individual requirements at reasonable prices.

In Memoriam

ROBERT RUTSON JAMES, F.R.C.S.
Consulting Ophthalmic Surgeon to St. George's Hospital

MR. RUTSON JAMES, who died on 28th September, 1959, a week before his seventy-eighth birthday had lived in retirement in Suffolk for more than twenty years. The son of a country clergyman he was educated at Winchester and St. George's Hospital, and qualified for the Fellowship before his twenty-fifth birthday. After working at Moorfields and the Royal Westminster Ophthalmic Hospital he was elected to the staff of St. George's in 1909, becoming consulting ophthalmic surgeon in 1931. He took a full share of professional duties and served as Dean of the Medical School at St. George's 1918-22, but had not really the temperament of a surgeon. His best work was done as secretary and editor of the Ophthalmological Society and editor of the *British Journal of Ophthalmology*; in these capacities his sound judgment, wide knowledge, and untiring industry had full scope.

At heart he was an antiquary and scholar, intensely interested in the old records of the medical profession and in local history. He was too modest to rush into print, but his few published contributions to medical history are models of accuracy. He left a mass of valuable unpublished work in the form of transcripts of old registers, notably those of the Barber-Surgeons and of St. George's Medical School, which he generously deposited in the College Library. His affection for the College was shown in the most practical way by constant gifts both large and small to the Library. He gave his unrivalled collection of bookplates of medical men, he subscribed for expensive works of reference, and he frequently sent small items of special interest or associations. He concluded nearly thirty years of constant generosity by sending a cheque for £1,000 last year to be used for library purposes.

Though he seldom came to London, Mr. James was held in warm affection by a large circle of ophthalmologists, old St. George's men, and other friends with whom he kept in touch by frequent correspondence. Mrs. James died last March, and he is survived by their daughter.

W.R.L.

DR. C. P. RHOADS, M.D.

DR. C. P. RHOADS, Director of the Sloan-Kettering Institute for Cancer Research, New York City, died on 13th August at the age of sixty-two during a sudden heart attack at his seaside home at Stonington on the Connecticut coast.

He graduated M.D. (cum laude) from the Harvard Medical School in 1924, becoming an Instructor in Pathology to the School and Associate Pathologist to the Boston City Hospital. He was appointed an associate of the Rockefeller Institute for Medical Research, New York, in 1928, later becoming an associate

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Dr. C. P. Rhoads (left) with Professor G. Hadfield at a meeting of the
Imperial Cancer Research Fund.

member and working at the laboratory bench for the next eleven years on many
research problems relating to human diseases, especially those of the
haemopoietic organs.

In 1940 he became Director of the Memorial Hospital for Cancer, New York,
an Institute closely associated with the name of James Ewing. In the same year
he became Professor of Pathology to the Cornell University School of Medicine.

From 1943 to 1945 he was a Colonel in the Medical Service of the U.S. Army
and chief of the Medical Service of Chemical Warfare. These were strenuous
years which gave him an opportunity to exercise his exceptional gifts for the
large-scale planning and organization of scientific projects.

His great opportunity came in 1945 when he was appointed Director
of the Sloan-Kettering Institute for Cancer Research, New York City.
It is no exaggeration to say that Rhoads was the creator of this mammoth
institute from which, since its inception, has flowed a steady stream of

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new knowledge based on scientific work of the highest quality. The fruitful clinical and academic connection with the near-by Cornell University School of Medicine was maintained.

This is no place to enumerate the many scientific disciplines represented, the large number of experienced clinicians and expert research workers employed, or the vast sums of money expended by Rhoads and his astute advisers in the equipment and accommodation of this enormous hive of clinical and scientific industry, but it will be universally agreed that " Dusty " Rhoads came to stand head and shoulders above his fellow-men in the vigour and intensity of his unremitting attack on human cancer.

Much of Dusty's scanty leisure was spent in the study of war, especially those campaigns in which his own country was involved. He arrived in London last summer a day before the opening of the International Cancer Congress, travelled by road to Portsmouth in the early morning, and spent a long day with his wife aboard Nelson's " Victory."

His attack on human cancer was that of an experienced general conducting a long campaign. He decided on a frontal attack on all fronts and for this he was well armed, not only by virtue of his outstanding and well-proved ability to plan, organize and maintain his massive assault but also, and probably of equal significance, because of his exceptionally firm grip of the basic qualities of sound scientific research and his uncanny genius in the selection of the units of his powerful, well-equipped and well-disciplined research army.

In Rhoads' own words, his primary objective was " to achieve better means for the cure and prevention of cancer in man." He deliberately deviated from " the objective of conventional cancer biology " in its efforts " to define the nature of cancer," having no wish " to decry its importance but rather to complement that discipline by a frankly pragmatic effort to reach a wholly desirable end." In other words, the Sloan-Kettering Institute was dedicated to a humanitarian ideal whose achievement, the alleviation of human suffering, was to Rhoads a matter of acute clinical urgency, scientific research being no more than a highly appropriate weapon for the purpose. A daily occurrence at the S.K.I. was the lunch-time conference at which scientists and clinicians were brought together in frank discussion, one group being constantly reminded of the stark realities of the clinical situation, the other becoming increasingly appreciative of the scientific effort.

The sense of urgency behind Rhoads' effort kept him always on active service, never sparing his associates and with little regard for his own leisure or peace of mind. For fifteen years his robust frame was equal to the excessive demands he made upon it. He was spared another five vigorous years but only by the support and care of his devoted wife and her quiet insistence that the pace must be slackened. Just before he died he had been working with his wife in the garden of their seaside home where they had spent so many happy hours together.

More formal accounts have been written of this outstanding figure, typical of the best in modern American civilization. Reading them makes one wonder how one man, in addition to the strenuous commitments of his own Institute, could have served as a trusted and reliable adviser to so many scientific bodies outside its walls. In 1956, our own College awarded him the Walker prize (1951-1955) in recognition of his

" . . . Distinguished career as an experimental pathologist and over the last ten years as Scientific Director at the Sloan-Kettering Institute and Memorial Hospital, New York, in building up the largest and most efficient cancer research organization in the world."

He came to London to receive the award and delivered an Imperial Cancer Research Fund Lecture, appropriately entitled " The Soluble Puzzle of Cancer Control."*

Dusty was a typical New Englander and came of Quaker stock. He had a keen sense of humour, the gift of making deep and abiding friendships and a strong sense of his responsibility to his younger research workers, who will treasure his kindness to them, be grateful for the opportunities he made for them, and for his deep interest in their personal welfare.

Unless the future reveals that neoplastic growth is determined by the operation of some biological or physical force whose very existence is now completely unknown to us, the work of Dusty Rhoads will surely play a vital part in the final eradication of cancer in man.

G.H.

* Published in the Annals, R.C.S., Engl., 1957, **20**, 139.

SAYINGS OF THE GREAT

" To intrude an unskilled hand into such a piece of Divine mechanism as the human body is indeed a fearful responsibility." (Lord Lister).

(Submitted by Mr. Irving Cawkwell, F.R.C.S., F.R.A.C.S.)

Contributions are invited.

THE COLLEGE TIE

THE DESIGN IS a College crest (an eagle proper holding a mace of gold) repeated on a maroon background. The tie is made in pure silk or silk and rayon, and also available are squares in the same design and tubular scarves. These may be worn by the following : Fellows and Members of the College ; Fellows and Licentiates in Dental Surgery ; Fellows of the Faculty of Anaesthetists ; Holders of the special diplomas granted by the Royal Colleges through the Conjoint Board ; postgraduate students attending educational courses at the College. The tie can be obtained from Messrs. T. M. Lewin & Sons Ltd., 1-3, Jermyn Street, St. James's, London, S.W.1.

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VISIT OF HER MAJESTY THE QUEEN TO CANADA

(Photograph reproduced by courtesy of " The Globe and Mail Limited ", Toronto).

DURING HER VISIT to Canada earlier this year, Her Majesty The Queen attended a Banquet given in her honour by the Province of Ontario while she was in Toronto.

The photograph shows the Hon. Keiller Mackay, LL.D., Lieutenant-Governor of the Province of Ontario (centre) presenting the Hon. Herbert A. Bruce, LL.D., M.D., F.R.C.S., F.A.C.S., to Her Majesty on her arrival for the Banquet.

Colonel the Hon. Herbert Bruce gained his Fellowship of this College in 1896, and at ninety-one years of age is the oldest Fellow residing in

Canada and the fourth oldest of all our Fellows. A leader in medical and surgical affairs of Canada for many years, and a Founder and Regent of the American College of Surgeons, he was Lieutenant-Governor of the Province of Ontario from 1932 to 1937 and was a Member of Parliament in the Canadian House of Commons from 1940 to 1946. His autobiography *Varied Operations* was published last year.

Some years ago Dr. Bruce was in correspondence with Sir Cecil Wakeley, Bt., at that time President of this College, and the following is an extract from a letter written by Dr. Bruce and dated 28th February, 1954.

" I have always been very proud of being a Fellow of the College and of having earned it by hard work, first at University College for the Primary and then by attending clinics and operations by many of the leading Surgeons of that day in the London Hospitals. This was an ever ready source of help and guidance, especially in the early years of practice. Amongst these were Joseph Lister, Watson Cheyne, Victor Horsley, Rickman Godlee, Frederic Treves, Bland-Sutton, Henry Morris and William MacCormac.

" For the final examination I joined a small tutorial class (of four) of Albert Carless, when we spent a winter of evenings at Carless' home going over the manuscript of Rose & Carless. As our criticisms were incorporated in the final proof, we prided ourselves as being co-authors of that excellent work.

" Dr. George Peters of Toronto, who died at an early age, was the first Canadian to obtain the Fellowship and I was the second."

HUNTERIAN TRUSTEES

AT A RECENT meeting of the Board of Trustees of the Hunterian collection, Sir Hugh Lett, Bt., K.C.V.O., C.B.E., F.R.C.S., did not seek re-election to the office of Chairman and Sir Victor Negus, F.R.C.S., was elected in his place. Sir Hugh Lett was elected as Vice-Chairman of the Trustees.

Sir Harry Platt, Bt., F.R.C.S., was elected a Trustee to fill the vacancy caused by the resignation of Sir Gordon Gordon-Taylor, K.B.E., C.B., F.R.C.S., who had been a member of the Board since 1955.

The Trustees made their annual inspection of the Hunterian Collection and found it in good preservation and order.

Tribute was paid to the work of Sir Hugh Lett during his term of office as Chairman, which post he had held from 1956, having been elected a Trustee in 1942. Prior to Sir Hugh's election as Chairman there had been no regular Chairman of the Hunterian Trustees, this office being filled at each meeting by the senior Elected Trustee present.

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PROCEEDINGS OF THE COUNCIL IN NOVEMBER

A MEETING OF the Council was held on 12th November, 1959, with Professor Sir James Paterson Ross, President, in the Chair.

The following were elected to the Court of Patrons of the College: Mr. L. J. Williams, Mr. Basil Mavroleon, Mr. G. A. Vandervell, Mr. Jack Cotton, Mr. Harold Samuel.

Professor Andrew Gilchrist Ross Lowdon, O.B.E., F.R.C.S.(Ed.), (1939) and Professor Andrew Wood Wilkinson, F.R.C.S.(Ed.) (1940), were elected to the Fellowship *ad eundem*.

The Lady Cade Medal was presented to Group Captain W. B. Thorburn.

Arrangements were made for the Annual Meeting of Fellows and Members on 9th December.

Diplomas of Membership were granted to 120 candidates.

The Begley Prize was awarded to Lydia Margaret Hayes of King's College Hospital Medical School.

The Hallett Prize was awarded to Hameed Ud-Din Ahmed of the University of Gauhati.

A Diploma of Fellowship was granted to G. R. Parry.

Licences in Dental Surgery were granted to eighty-nine candidates.

Among the gifts reported were the Lilian May Coleman Fund for Cancer Research (stock to the value of £28,000) from Mr. Cecil R. Coleman, C.B.E., of Leicester and a grant from the Peel Medical Trust of £2,000 per annum for three years for the Department of Pathology for research into X-ray microscopy which were gratefully received.

One Diploma of Fellowship in Dental Surgery and eleven Diplomas in Orthodontics were granted.

Diplomas were granted, jointly with the Royal College of Physicians to one candidate in Tropical Medicine and Hygiene and 110 in Child Health.

The following hospitals were recognised under paragraph 23 of the Fellowship Regulations:

HOSPITALS	POSTS RECOGNISED		
	General (6m unless other-wise stated)	Casualty (all 6m.)	Unspecified (all 6m.)
LONDON — Paddington General Hospital (additional)			S.H.O. (Orth.)
ENFIELD—Chase Farm Hospital (additional)			*Under para.* 23 (*c*) Regr. (E.N.T.) S.H.O. (E.N.T.)
LONDON—Wembley Hospital ..	Surg. Regr. (12m.)	Cas. Off. (J.H.M.O.)	
STOCKPORT—Stockport Infirmary (additional)		S.H.O. (Cas. & Orth.)	
STIRLING—Royal Infirmary ..	Regr. 2 Junior H.O.s	2 Junior H.O.s (Gen. & Cas.)	Regr. (Cas. & Orth.)
CLACKMANNAN—County Hospital	S.H.O.	Junior H.O. (Gen. & Cas.)	
CUCKFIELD Hospital (additional)		S.H.O.	

DONATIONS

THE FOLLOWING GENEROUS donations have been received by the College during the last few weeks :

Appeal Fund—Donations

£306 5s. 0d. + tax	Trustees of Bernard Sunley Voluntary Settlement (further contribution).
£262 10s. 0d.	G. Sainsbury Ltd.
£250	Rowntree & Co. Ltd.
	N. & O. Black, Ltd.
£52 10s. 0d.	E. B. Cockcroft, Esq.
£25	C. Tennant, Sons & Co. (Investments) Ltd.
	Kimberly-Clark, Ltd.
	Humphreys & Glasgow Ltd.
£20	A. G. Rampton, Esq.
£10 10s. 0d.	Harry Peck & Co. Ltd.
	Mabel Peatfield Charities (further contribution).
	Samuel Williams & Co. Ltd.
	Samuel Mason, Esq.
£10	R. Scott, Esq.
£9	Mrs. E. I. Chittenden
£5 5s. 0d.	L. W. Baylis, Esq.
	Hallam, Sleigh & Cheston, Ltd.
	Mellowes & Co. Ltd.
£5	Mrs. Vera Roberson
£3 10s. 0d.	St. George's Church, Hanover (collection).
£2 2s. 0d.	British Rolling Mills, Ltd.

Appeal Fund—Covenants

£437 10s. 0d. p.a. for 7 years, + tax	Sir Edward Baron
£100 p.a. for 7 years, + tax	A. Wander, Ltd.
	Liverpool Daily Post & Echo.
£82 p.a. for 7 years	The Lancet, Ltd.
£50 p.a. for 7 years, + tax	John Swire & Sons, Ltd.
£30 p.a. for 7 years	The Times Furnishing Co. Ltd.
£20 p.a. for 7 years	Harvey, Trinder & Van Ommeren.
£10 10s. 0d. p.a. for 7 years + tax	H. Tavener, Esq.
	Escombe, McGrath & Co. Ltd.
£10 p.a. for 7 years, + tax	H. & G. Simonds, Ltd.
£5 p.a. for 7 years, + tax	John Tavener, Esq.
£3 3s. 0d. p.a. for 7 years, + tax	Bird & Co. (London) Ltd.

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DONATIONS

Restoration & Development Fund

£2,000   International Congress on Plastic
                                          Surgery.

Down House Fund

£50   H. R. Viets, Esq.
£2   2s.   0d.   P. Sloan, Esq.

Research Department of Anaesthetics

£2,500   Glaxo Charity Trust (further donation).

Coulthurst Room (Library)

£105   Mrs. J. B. Coulthurst.

Endowment of Chair of Biochemistry

£10,000   Jack Cotton Charitable Trust (further
                                          contribution).

Voluntary annual subscriptions and donations by Fellows

The following Fellows of the College, Fellows in Dental Surgery, and Fellows in the Faculty of Anaesthetists have generously given donations or have undertaken to make an annual subscription under Covenant to the College:

N. J. Ainsworth, F.D.S.R.C.S.
C. V. Armitage, F.D.S.R.C.S.
B. W. Adams, F.F.A.R.C.S.
D. W. Bain, F.R.C.S.
H. J. C. Ball, F.F.A.R.C.S.
T. L. S. Baynes, F.R.C.S.
H. R. Blades, F.F.A.R.C.S.
D. Blatchley, F.F.A.R.C.S.
B. T. Broadbent, F.D.S.R.C.S.
J. C. Buckley, F.F.A.R.C.S.
H. W. Burge, M.B.E., F.R.C.S.
D. A. M. Carr, F.F.A.R.C.S.
R. D. Cundall, F.R.C.S.
A. S. Daly, F.F.A.R.C.S.
R. M. Davies, F.F.A.R.C.S.
B. S. Dhillon, F.R.C.S.
A. R. Dingley, F.R.C.S.
J. D. Ebsworth, F.F.A.R.C.S.
G. Edwards, F.F.A.R.C.S.
I. C. W. English, F.F.A.R.C.S.
H. Fairley, F.F.A.R.C.S.
A. V. Forage, F.R.C.S.

A. C. Forrester, F.F.A.R.C.S.
R. E. Gibson, F.F.A.R.C.S.
C. Gill-Carey, F.R.C.S.
G. N. Golden, F.R.C.S.
J. Gordon, F.F.A.R.C.S.
V. F. Hall, F.F.A.R.C.S.
M. J. Harker, F.F.A.R.C.S.
W. J. L. Harries, F.R.C.S.
G. Harrison, F.F.A.R.C.S.
L. G. Higgins, F.R.C.S.
N. E. James, F.R.C.S.
A. B. King, F.R.C.S.
G. E. Larks, F.R.C.S.
C. J. Longland, M.V.O., F.R.C.S.
R. W. Lovel, F.D.S.R.C.S.
A. B. MacGregor, F.D.S.R.C.S.
A. G. McPherson, F.R.C.S.
R. Marcus, F.R.C.S.
A. J. Marsden, F.R.C.S.
S. Mawson, F.R.C.S.
Surg. Vice-Admiral Sir Cyril May,
          K.B.E., C.B., M.C., F.R.C.S.

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DONATIONS

R. P. M. Miles, F.R.C.S.
E. W. T. Morris, F.R.C.S.
W. Nuki, F.D.S.R.C.S.
J. N. Ormrod, F.R.C.S.
J. H. Peel, F.R.C.S.
G. C. L. Pile, F.R.C.S.
H. G. Radden, F.D.S.R.C.S.
M. C. T. Reilly, F.R.C.S.
A. G. Riddell, M.B.E., F.R.C.S.
R. H. C. Robins, F.R.C.S.
A. E. Robinson, F.D.S.R.C.S.
F. Robinson, F.R.C.S.

H. L. M. Roualle, F.R.C.S.
J. W. E. Snawdon, F.D.S.R.C.S.
D. F. Soul, F.D.S.R.C.S.
J. L. Temple, F.R.C.S.
N. N. Iovetz-Tereshchenko, F.R.C.S.
A. B. Watson, F.R.C.S.
A. Hedley Whyte, D.S.O., T.D., F.R.C.S.
Surg. Rear-Admiral F. R. P. Williams, C.B.E., F.D.S.R.C.S.
O. H. Williams, F.R.C.S.
K. C. Wybar, F.R.C.S.

Mr. J. C. Barrett, V.C., T.D., F.R.C.S., has kindly presented a Chair for the Edward Lumley Hall.

COLLEGE PUBLICATIONS

READERS ARE REMINDED that the following publications issued or sponsored by the College may be obtained from the Editorial Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2.

Lives of the Fellows, 1930-1951. By the late Sir D'Arcy Power, K.B.E., F.R.C.S., Honorary Librarian, and continued by W. R. Le Fanu, M.A., Librarian. A single volume, bound in blue cloth, of 889 pages, containing the Lives of all Fellows known to have died between 1930 and 1951. £2 2s. 0d. post free.

A Record of the Years from 1901 to 1950. Edited by Sir Ernest Finch, M.D., M.S., F.R.C.S. A slim volume, illustrated, containing a brief history of the College between the centenary and the 150th anniversary of the foundation with lives of all the Presidents since 1900, written by special contributors from their personal knowledge. In red cloth 9s. post free or red paper covers 5s. 6d. post free.

John Hunter, a List of his Books. A short-title bibliography of all known editions of John Hunter's books, compiled by the Librarian. Printed at the Cambridge University Press, and bound in green cloth. 2s. 6d. post free.

A Guide to the Hunterian Museum (Physiological Series). This gives a brief account of the physiological section of John Hunter's museum, the scope, design and historical value of which is unique. 48 pp. 1s.

A Descriptive and Historical Catalogue of the Darwin Memorial at Down House. Charles Darwin and his family lived at Down House, near Orpington, Kent, for forty-two years and it was here that most of his scientific investigations were made, including his work on the Origin of Species, published in 1859. 33 pp. 1s.

The Portraiture of William Harvey. The Thomas Vicary Lecture for 1948 by Geoffrey Keynes, M.A., M.D., F.R.C.S. With a descriptive catalogue and 33 reproductions of the portraits. £1 5s. 0d.

*William Clift. By Jessie Dobson, B.A., M.Sc., Anatomy Curator. A new biography, fully illustrated, of the first Conservator of the Museum at the College. Published by William Heinemann Medical Books Ltd. Bound in blue cloth; 144 pages with frontispiece portrait and 31 plates. 8s. 6d. post free.

The present position of cardiac surgery. The Bradshaw Lecture for 1957 by Sir Russell Brock, M.S., F.R.C.S. Blue cloth binding, 6s. 0d. post free.

* A separate cheque for this publication would be appreciated.

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A NEW CATALOGUE OF PORTRAITS

MESSRS. E. AND S. LIVINGSTONE are publishing a new *Catalogue of the Portraits and Paintings in the College,* which has been compiled by the Librarian. Its production with many illustrations has been made possible by a very generous gift from Mr. McNeill Love in memory of his son Michael.

The portraits form a vivid historical record of the great personalities of British surgery. The likenesses of Richard Wiseman, William Cheselden, Percivall Pott and the two Hunters look down from the walls of the Council Room while the great Hall is adorned with portraits of Astley Cooper, Sir William Lawrence, Lord Lister, Sir William MacCormac and other great men of the nineteenth century. The surgeons of " the day before yesterday " are represented among others by Bowlby, Bland-Sutton, and Moynihan, who are followed by most of the more recent Presidents. Many of these fine portraits have been generously presented. From the artistic aspect the collection is most distinguished, including canvases by Hogarth, Reynolds, Romney, Lawrence and other painters from the golden age of English portraiture. The later paintings are almost as interesting with fine portraits by John Opie, Archer Shee, George Richmond, W. W. Ouless, John Collier, among others, and in our own time Sir Oswald Birley and Mr. James Gunn. Several of the most famous British sculptors are represented by fine bronze or marble busts such as Nollekens' " Matthew Baillie," Alfred Gilbert's " Richard Owen " and Epstein's " Sir William Collins." There are also several examples of Sir Francis Chantrey's work and two striking early eighteenth-century terracotta busts, attributed one to Rysbrack and the other to Roubiliac.

The Hunterian pictures, which John Hunter commissioned for his Museum, are fully described for the first time, and the most interesting are reproduced. They include three superlative animal portraits by George Stubbs, whose work is now so much admired.

It is nearly thirty years since the late Sir Frederic Hallett's Catalogue of the portraits then in the College was published. It has long been out of print, and the collection has been very greatly increased in the meantime. The new Catalogue contains descriptions of all the portraits and paintings, with details of their history ; there are four coloured plates and more than 100 black-and-white illustrations.

The *Catalogue of Portraits* may be ordered from any bookseller or from the College, price 30s. a copy.

LIST OF " OBSERVABLES " DESCRIBED IN THE ANNALS JULY 1947—JUNE 1958

The first number shows the volume; the second number shows the monthly issue; the third number shows the page

DIARY FOR DECEMBER

Tues.	1	5.00	Dr. M. J. F. McArdle—Facial pain.
		6.15	Dr. V. Goldman—General anaesthesia—I.
Wed.	2		Second L.D.S. Examination begins.
		5.00	Board of Faculty of Anaesthetists
Thur.	3		Pre-medical Examination, D.L.O. Examination (Part I) and D.P.M. Examination (Part II) begin.
		5.00	Dr. H. G. H. Richards—Erasmus Wilson Demonstration*
		5.00	Mr. S. H. Wass—Osteomyelitis of the jaws.
		5.30	Mr. Norman R. Barrett—Otolaryngology Lecture*
		6.15	Dr. V. Goldman—General anaesthesia—II.
Mon.	7		Basic Sciences Lectures and Demonstrations for Dental Students begin.
Tues.	8	4.00	Dr. E. F. Scowen—Imperial Cancer Research Fund Lecture—Hormone dependent cancer : The present position*
		5.00	Prof. R. B. Lucas—Pathology of oral neoplasms—I.
		6.15	Prof. H. C. Killey—Surgery in relation to prostheses.
Wed.	9		Annual Meeting of Fellows and Members.
			Primary F.F.A. Examination and D.P.H. Examination begin.
		2.30	Lord Cohen of Birkenhead—Watson-Jones Lecture—Reflections on specialism in medicine*
		3.30	Annual Meeting of Fellows and Members.
Thur.	10		First Membership Examination and D.L. Examination (Part II) begin.
		2.00	Ordinary Council.
		5.00	Prof. H. H. Nixon—Hunterian Lecture—An experimental study of propulsion in isolated loops of intestine and application of the findings in the surgery of neonatal intestinal obstruction*
		5.00	Prof. R. B. Lucas—Pathology of oral neoplasms—II.
		6.15	Mr. G. T. Hankey—Disorders of the mandibular joint.
Fri.	11		Date of Election of Fellows to the Board of Faculty of Anaesthetists announced.
Tues.	15	5.00	Dr. W. Campbell—Radiology of the facial bones—I.
		6.15	Mr. C. R. McLaughlin—Cleft palate.
Thur.	17	5.00	Dr. R. M. H. McMinn—Arris and Gale Lecture—The cellular anatomy of experimental wound healing*
		5.00	Dr. W. Campbell—Radiology of the facial bones—II.
		6.15	Mr. Terence Ward—Fractures of the facial bones—II.
Fri.	18		Basic Sciences Lectures and Demonstrations and Dental Lectures and Clinical Conferences end.
Thur.	24		College closed.
Fri.	25		Christmas Day. College closed.
Sat.	26		College closed.
Mon.	28		College closed.
Thur.	31		D.I.H. Examination begins.

DIARY FOR JANUARY

Fri.	1		Last day for nomination of candidates for election to the Board of Faculty of Anaesthetists.
Tues.	5		Final Membership Examination begins.
Tues.	12		Final F.D.S. Examination begins.
Thur.	14	2.00	Quarterly Council.
		5.00	Sir Walter Mercer—Robert Jones Lecture*
Fri.	15	5.00	Board of Faculty of Dental Surgery.
Mon.	18		Basic Sciences Lectures and Demonstrations begin.
Tues.	19		Voting Papers for election of Fellows to Board of Faculty of Anaesthetists issued.
			Final F.F.A. Examination begins.
Wed.	27		Primary F.R.C.S. Examination begins.
		5.00	Dr. D. H. Tompsett—Arnott Demonstration*
Thur.	28	5.00	Lt.-Col. J. C. Watts—Hunterian Lecture—Missile injuries in Cyprus*

*Not part of the courses.

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CARCINOID TUMOURS (ARGENTAFFINOMATA)

Hunterian Lecture delivered at the Royal College of Surgeons of England

on

3rd March 1959

by

A. J. Davies, M.S., F.R.C.S.

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IN RECENT YEARS a great deal of interest has been aroused by a newly-described syndrome of carcinoidosis, flushing attacks, hyperactivity of the bowel and valvular lesions of the heart. In this lecture I would like, in addition to describing this syndrome, to discuss the possible functions of argentaffin cells and 5 hydroxy-tryptamine in the body, with some comments on the pathology, diagnosis and management of carcinoid tumours. Unfortunately, the lecture must be incomplete for the mechanisms producing this syndrome are not understood, nor has any adequate form of treatment been devised.

In the study of carcinoid tumours there is no single unknown factor. Here we have a cell, the argentaffin cell, first described nearly ninety years ago, yet whose function in the body is not known. Recently it has been suggested that it stores or synthesises a chemical, 5 hydroxy-tryptamine. This substance has a series of interesting physiological and pharmacological actions, and quite clearly must play a most important part in the hormonal balance of the body, yet again its exact role is not known.

THE ARGENTAFFIN CELL

Historical review

Argentaffin cells were first described by Heidenhain in 1870. He found small darkly-staining round cells in the stomach wall of animals after prolonged exposure to potassium dichromate. He believed that they were the precursors of the parietal cells. He failed, however, to demonstrate their granular appearance. Further work was carried out by Kultschitzky (1897) who found them in the crypts of Leiberkuhn and showed the granularity. For many years these cells have borne his name, quite unjustly in my opinion. Their silver reducing action was not demonstrated until 1914 when Masson found this characteristic staining reaction.

Distribution

The cells are found widely throughout the vertebrate kingdom. They are distributed throughout the gastro-intestinal tract, being profuse in the terminal ileum and appendix and sparse in other parts of the gut. They are also found in the gall bladder, bile ducts and in Meckel's diverticula.

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The cells usually occur singly, related to the basement membrane, but rarely will be found in pairs and in foetal life tend to be in groups.

Development

The early workers believed that, like the gut epithelium, the argentaffin cells were endodermal in origin. However, now it is believed that they are more likely to have arisen from ectoderm, possibly from neural crest tissue with early migration to the gut. They appear first in the large gut of the twelve-week human foetus, being present in larger numbers than at any time in later development. They appear in groups, four or five cells clumped closely together, unlike the adult appearance. If migration has occurred, it would, of course, have been completed long before the cells developed their silver reaction (Fig. 1).
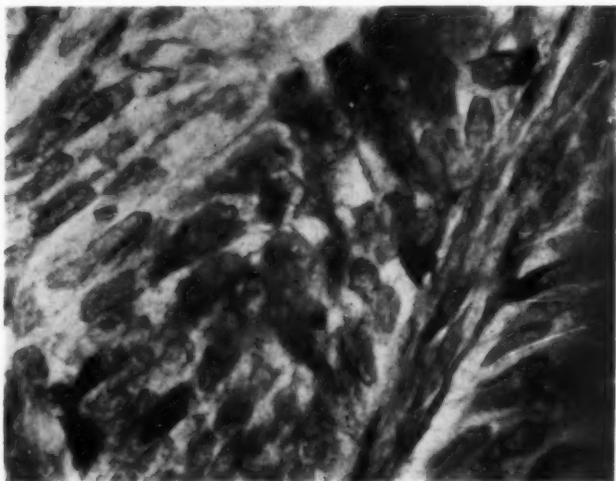
Fig. 1. Argentaffin cells in the colon of a sixteen-week foetus. (Silver impregnation × 780.)

Histology

The cells are usually found, in contact with the basement membrane, between the mucous and columnar cells. There is considerable variation in cellular shape, undoubtedly dictated by the pressure of the surrounding cells. The most striking feature is the basal granulation. These granules do not exist in the unfixed state and are due to a chemical artefact produced by the formalin fixative reacting with some substance, possibly 5 hydroxy-tryptamine, in the cell. Post-mortem examination of the gut frequently fails to reveal argentaffin cells, for they degenerate completely within six hours. The cell nucleus is situated above the basal granules but, in spite

of its clarity, no conclusions have been reached concerning its mode of mitosis. Situated amongst the granules are vacuoles which have been shown to contain crystals. By using fat stains and polarised light, it has been suggested that the substance is cholesterol. Once more the significance of the vacuoles, if any, is not known. The apex of the cell is usually in contact with the lumen, and earlier workers concluded that it opened into the gut with periodic discharge of granules.

Functions

The following table outlines the more important theories concerning the possible function of the argentaffin cells in the body :

TABLE I
EXOCRINE FUNCTION
1. Increase in starvation (Toro, 1929)
2. Increase in feeding (Kultschitzky, 1897)
3. Purely digestive, with discharge of granules into the gut (Cordier, 1926)

ENDOCRINE FUNCTION
1. Related to Islets of Langerhans (Eros, 1930)
2. Production of secretin (Parat, 1924)
3. Adrenaline production (Ciaccio, 1906)
4. Neurocrine function (Masson, 1928)
5. Haemopoietic function (Jacobsen, 1939)
6. Enteramine (5 H-T) production (Erspamer, 1937-40)

The earlier workers believed that the cells were exocrine, with an important part to play in digestion. Their results were subject to considerable variation, the changes that they attributed to phases of digestion are almost certainly explained by the vagaries of the staining techniques. Cordier's work has been repeated on many occasions using local applications of acid and alkali to the mucous membrane, variations in diet and intravenous pilocarpine, which causes release of granules in other digestive cells, without confirming his findings.

Of the theories of endocrine function, I think only the last three are worthy of discussion. Masson believed that these cells had a neurocrine function, producing a chemical which was poured on to local sympathetic nerve endings activating them. This was, in fact, acting as a synaptic mediator. I will discuss later further theories which show that his basic idea might well have been correct.

Jacobsen's theory of haemopoietic function is an interesting one. He believed that the cells produced the intrinsic factor. This conclusion was based on the post-mortem examination of twelve patients suffering from pernicious anaemia. On microscopy he found that the cells were absent in six and reduced in the remainder. One possible explanation of this finding is that the argentaffin cells may have undergone post-mortem degeneration, although Jacobsen was careful to consider this in his selection of cases. Evidence against this theory was produced by Gillman

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(1942) working with the Bantu tribes. He could find no single recorded case of pernicious anaemia in these people, nor could he find a single argentaffin cell in the stomach wall examined within one hour of death.

Erspamer's work brings us up to date. It is now generally accepted that the substance he named enteramine (serotonin to the Americans) is identical with 5 hydroxy-tryptamine. I will discuss more recent work in a later section.

5 HYDROXY-TRYPTAMINE (Enteramine or Serotonin)

5 hydroxy-tryptamine (for brevity I would like to refer to it as 5 H-T) is found widely throughout the plant and animal kingdoms. It is formed by enzymic action on tryptophan (Fig. 2). This pathway has been traced
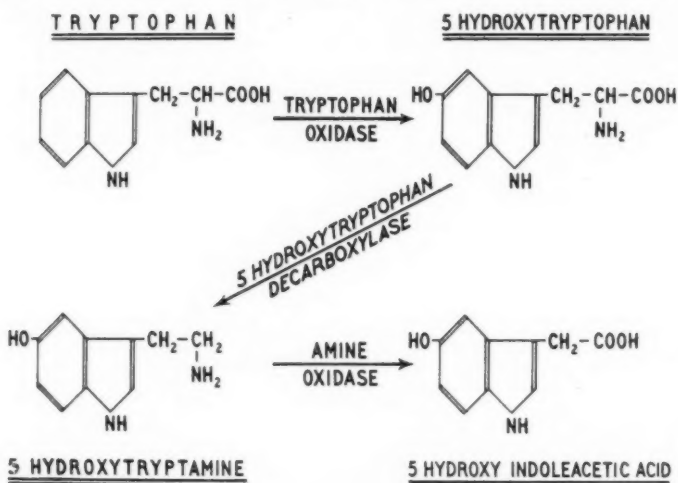
Fig. 2. The metabolic pathway of 5 hydroxy-tryptamine.

in the toad, using radio-active tryptophan with recovery of 5 hydroxy-indoles from the venom (Udenfriend, et al., 1953-54). Until recently it was considered that the 5 H-T synthesis occurred only in the argentaffin cell. However, it has been shown that the decarboxylase is present in many other tissues in the body and brain. It seems likely that there might be other sites of synthesis of 5 H-T and perhaps the argentaffin cell produces only the precursor of 5 hydroxy-tryptophan. This would explain the presence of 5 H-T in the brain, for it is known that it will not cross the blood-brain barrier, whereas its precursor is able to cross it. The cycle could then be completed by the decarboxylase in the brain. The final breakdown to 5 hydroxy-indole acetic acid is catalysed by mono-amine oxidase. This enzyme is found in the lungs and also in the hypothalamic

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region of the brain. It is possible then that there are two entirely separate spheres of action of 5 H-T in the body, with destruction in the lungs, and in the brain, with destruction in the hypothalamus.

The levels of 5 H-T in the blood are between 0.1 to 0.3 micrograms/mil., most being recovered from the platelets. The breakdown product, 5 hydroxy-indole acetic acid is excreted normally at levels of 2 to 10 mgm./ 24 hours (or 3 to 9 mgms./gram of creatinine excreted). There appears to be no sex or age variation in either the blood or the urinary levels.

In certain diseases there is variation in the level of circulating 5 H-T. It is depressed in phenylketonuria, and I will discuss at a later time a possible explanation of the variations in this disease, and a use we have made of this observation. In carcinoidosis the level of 5 H-T may be markedly raised. Lembeck (1953) was able to extract large quantities of 5 H-T from the tumour itself. In malignant carcinoids levels of 0.5 to 2.5 micrograms/mil. (5 to 10 times normal) are often found. There is also an increase in 5 hydroxy-indole acetic acid excretion (as high as 300 to 400 mgms. in twenty-four hours).

A tremendous amount of work has been undertaken on this substance in the last five years. Dr. Irvine Page of Cleveland, in a physiological review published earlier this year, discussed 529 papers presented on the subject. Quite clearly it would be completely impossible and, indeed, beyond the scope of this lecture to discuss even the smallest portion of this work.

Functions

Four main theories have been advanced concerning the function of 5 H-T in the body :

(1) *Influencing haemostasis.* It has been known for many years that blood liberates a vasoconstrictor substance on clotting. The platelets do carry 5 H-T and this is known to be a local vasoconstrictor. However, there is no certain answer as to whether this is its prime function, but its wide distribution, particularly in the brain, makes it less likely. Animals, depleted of over 90 per cent. of their platelet 5 H-T, did not have the prolongation of their bleeding time that one would have expected (Shore, *et al.*, 1956).

More recently workers have suggested that 5 H-T plays an important part in the clotting mechanism. Milne and Cohn (1957) believe that it acts by inhibiting the anti-thrombin which prevents spontaneous clotting in circulating blood.

(2) *Controlling vascular tone.* Page and McCubbin (1953) suggested that the function of 5 H-T in the body was to control vascular tone and so modify the blood pressure. They believed that it must have a dual action. First, acting directly on the arteriolar smooth muscle, producing vaso-constriction, and secondly, acting reflexly, inhibiting the neurogenic tone.

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They believe that the reflex inhibition is the most important physiolog -
cally, being produced by relatively small amounts of 5 H-T. The vas -
constrictor effect would only predominate if large quantities of 5 H-T
were liberated at one time. I think that this unwieldy explanation may be
dismissed, for if the amounts of 5 H-T required to produce even minor
pressure changes were available, then all the platelets would have to be
depleted of it at one time.

(3) *Regulating kidney function.* Erspamer believes that 5 H-T is
concerned with regulating kidney function by modification of the renal
circulation. He believes that the action is an entirely local one, not in any
way related to the anti-diuretic hormone of the posterior lobe of the
pituitary. This hypothesis has been supported by a great deal of impressive
experimental evidence. However, its application in man is still in doubt.
Two observations of clinical interest have been reported (Annoni,
Luchellini and Barbieri, 1955). They have demonstrated a marked anti-
diuretic effect after 5 H-T administration in two patients suffering from
diabetes insipidus. This does raise the possibility that this substance may
be of value in the management of this disease.

(4) *Maintaining normal mental processes.* This is by far the most
exciting theory in my opinion. It is known that 5 H-T is necessary for the
normal functioning of the brain. Experimental work using anti-metabolites
has produced a variety of temporary mental changes in normal subjects.
Could lack or excess of 5 H-T in the brain lead to mental changes?
This problem is being fully investigated, and much experimental work,
clinical trials and even more conjecture are being carried out at the present
time. It is, however, a hopeful advance in a subject that has been virtually
static therapeutically for many decades. A suggested mode of action of
5 H-T in the brain is that it is the synaptic mediator of the central para-
sympathetic, in much the same way as noradrenaline is of the sympathetic.
This theory is reminiscent of Masson's theory of neurocrine function for
the argentaffin cells. There is much work yet to be done before a purely
biochemical basis for mental disease can be accepted.

This brief outline of 5 H-T must of necessity be sketchy but I hope that
I have given sufficient information to enable a clearer understanding of
the possible importance of this substance in the body.

CARCINOID TUMOURS
Historical review

In 1907 Obendorfer suggested the name carcinoid for a group of
tumours that were histologically unlike the adenocarcinomata of the
bowel. Following this classication there was argument concerning the
developmental origin of the tumours. Some workers believed that they
developed from pancreatic or epithelial rests (Trappe, 1907; Toennissen,
1909), whilst others allied them to the basal-celled carcinoma of the skin
(Burkhardt, 1909). It is, however, now generally accepted that they develop
from the argentaffin cells.

In the following years there were occasional reports citing examples of these rare pathological curiosities. Further interest was stimulated by Lembeck (1953) when he found that it was possible to extract large quantities of 5 H-T from the tumours. In the following year Thorson and his colleagues from Scandinavia described an apparently newly recognised syndrome of carcinoidosis, vascular cutaneous flushing, hyperactivity of the bowel, associated with valvular lesions affecting mainly the right side of the heart. These reports were widely acclaimed as the earliest recorded cases. It is correct that this was the first time that the syndrome had been recognised, but Sir Maurice Cassidy at the Royal Society of Medicine in 1930, 1931 and 1933 gave classical descriptions of two cases of carcinomatosis with flushing. In one of these patients a pulmonary stenosis was found to be present at post-mortem examination. The significance of these changes escaped the observers who suggested that they might be due to malignant replacement of the adrenal glands. At post-mortem examination the adrenals of both patients showed no involvement.

Pathology

Carcinoid tumours occur throughout the gastro-intestinal tract.

TABLE II
DISTRIBUTION OF TUMOURS (705 CASES)

Organ						" Benign "	Malignant
Stomach ..	..	..	..	..	..	23	8
Duodenum	..	..	..	..	..	17	5
Gall bladder	..	..	..	..	..	3	1
Jejunum ..	..	..	..	..	..	14	14
Meckel's diverticulum	..	..	..	..		9	2
Ileum	..	..	..	..	..	93	124
Appendix	..	..	..	..	..	213	21
Ileo-caecal valve and colon		..	..	..		9	32
Rectum ..	..	..	..	..	..	61	12
Flushing syndrome	..	..	..	..		—	37
Unknown primary	..	..	..	..		—	3
Ovarian teratoma	..	..	..	..		4	—

By far the commonest sites for lesions are in the terminal ileum and appendix. The greater proportion of the appendicular growths are " benign "

TABLE III
AGE DISTRIBUTION

Organ						" Benign "	Malignant
						Years	Years
Stomach ..	..	..	..	..	..	75.5	57.5
Duodenum	..	..	..	..	..	56.2	55.4
Gall bladder	..	..	..	..	..	65	68
Jejunum ..	..	..	..	..	..	53.7	65.2
Meckel's diverticulum	..	..	..	..		48.3	54
Ileum ..	..	..	..	..	..	57.3	57.4
Appendix	..	..	..	..	..	31	33.4
Ileo-caecal valve and colon		..	..	..		61.6	60.2
Rectum ..	..	..	..	..	..	46.6	44
Flushing syndrome	..	..	..	..		—	50.5

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in nature, that is that the infiltration, if any, has not spread beyond the meso-appendix. The ovarian teratomata are included in this series because the tumours developed in intestinal epithelium contained in the teratoma.

In common with many carcinomata these tumours tend to develop in the late middle and older age groups. There are, however, two exceptions. In the appendicular group the patients are younger, being in the thirties. I believe the explanation for this is two-fold. First, the appendix is taken out more often than any other organ in the abdomen for disease or as an incidental procedure. Secondly, the lumen of the appendix is small and with basal lesions, particularly, more likely to be obstructed by the smaller tumours than, say, the small gut.

In rectal carcinoids the age group is still well below the average, in the forties. The explanation for this is, I believe, that at this age people with rectal bleeding, from perhaps haemorrhoids, are submitted to routine sigmoidoscopy to exclude carcinoma of the rectum, and the carcinoid found incidentally. This is borne out by the fact that of the sixty-one benign tumours, fifty-two were found on routine sigmoidoscopy.

TABLE IV
SEX DISTRIBUTION

				Male	Female
Whole series (684)	..	..	..	..	330	354
Appendix only (233)	..	..	..	..	79	154

Fig. 3. A carcinoid tumour of the terminal ileum, with secondary deposits in the ileo-caecal lymph gland.

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For the whole series the sex distribution is approximately equal. In the appendicular cases there were almost twice as many females as males. The explanation for this may be considered to be explained by the fact that at gynaecological operations the appendix is removed more often as an incidental procedure than in any other type of operation. Even allowing for this, however, there is still a significant female predominance which is not explicable.

Macroscopically, the growth is usually sub-mucous, most commonly plaque-like although annular and polypoid lesions are seen (Fig. 3). It is usually of a yellowish colour, although the primary or secondary deposits may be white, grey or orange. This coloration is due to the presence of pterins in the cell. The tumour may show a false appearance of encapsulation ; this is most marked in the appendicular lesions where, on section of the meso-appendix, infiltration is often present. In the adjacent intestinal wall there is usually an apparent hypertrophy of the muscle coats. This cannot be attributed to a hypertrophy following sub-acute obstruction, for it is seen in the intestinal components of ovarian teratomata when a carcinoid tumour is also present.

Microscopically the lesion is seen to be sub-mucous ; it may be in the form of islands, columns or attempted glandular formation (Fig. 4). Typically carcinoid tumours produce a marked fibrous tissue stroma as they infiltrate. This can lead to intestinal obstruction by kinking the gut. However, some tumours do not produce any stroma and are really
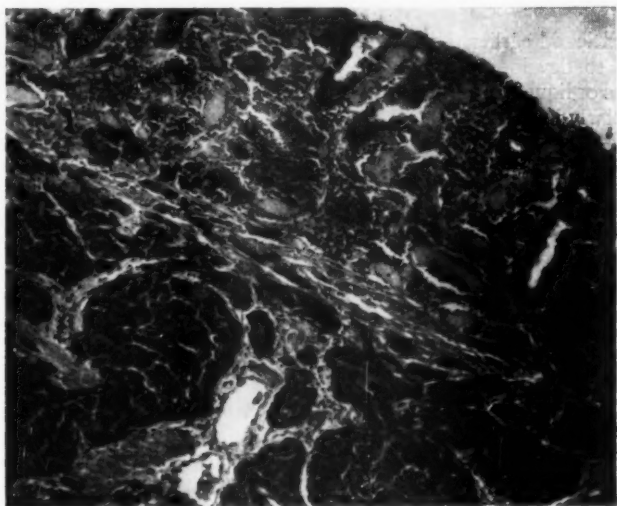
Fig. 4.   Carcinoid tumour of the appendix. (Haem. and Eosin ×110)

nothing more than a solid sheet of malignant cells (Fig. 5). The peri-neural lymphatics are invaded quite early, and finally the larger lymphatic channels, lymph glands and blood vessels are involved (Figs. 6 and 7).

I would like to mention briefly carcinoid tumours of the rectum. These are unlike tumours elsewhere in that it is most unusual for them to have a silver reaction. It has been suggested that this is because they develop from a more primitive type of cell, the pre-enterochrome or pre-argentaffin cell. These tumours, too, have a typical appearance, classically described as " ribbon-like festoons of prismatic and columnar cells."

Although carcinoids are said to be of low-grade malignancy, they do in some cases metastasise widely.

TABLE V

DISTRIBUTION OF METASTASES (259 CASES)

Region										Number of cases
Lymphatic	..	..	..	..	..	..	..	..	..	162
Liver ..	..	..	..	..	..	..	..	..	..	125
Mesentery	..	..	..	..	..	..	..	..	..	94
Peritoneum	..	..	..	..	..	..	..	..	..	46
Bone ..	..	..	..	..	..	..	..	..	..	11
Lungs	..	..	..	..	..	..	..	..	..	9
Ovary	..	..	..	..	..	..	..	..	..	9
Pancreas	..	..	..	..	..	..	..	..	..	7
Omentum	..	..	..	..	..	..	..	..	..	6
Spleen..	..	..	..	..	..	..	..	..	..	5
Adrenal	..	..	..	..	..	..	..	..	..	4
Skin ..	..	..	..	..	..	..	..	..	..	4
Thyroid	..	..	..	..	..	..	..	..	..	2
Testicle	..	..	..	..	..	..	..	..	..	2
Mediastinum and heart		..	..	..	..	..	..	..	..	2
Kidney	..	..	..	..	..	..	..	..	..	1

I mentioned earlier that it is most unusual for even the larger primary lesions to develop surface ulceration but they may undergo a central necrosis or liquefaction. This change also occurs in the secondary deposits, particularly in the liver.

Before passing on to the symptomatology I would like to remind you that carcinoid tumours can no longer be regarded as innocent. Some workers believe that they will always metastasise in time (Burkhardt, 1909), whereas others classify them as adeno-carcinomata, grade I (Broders) (Hopping and Dockerty, 1942). Once more I would like to single out rectal carcinoids. In Table II there were twelve malignant cases listed, and of these nine were dead from recurrence within two years. As was mentioned earlier, these tumours do develop from a more primitive type of cell and, like others developed from primitive cells, may tend to be more highly malignant.

Symptomatology

From the world literature I have collected 705 cases, of these 431 (62 per cent.) had symptoms that could have been caused by the tumour. One hundred and thirty-eight of these cases were malignant small gut growths and of these 70 per cent. had symptoms, and 50 per cent. pre-

Fig. 5. (a) Ileo-caecal valve carcinoid tumour. An unusual appearance with no stroma. (Haem. and Eosin × 200) (b) The typical microscopic appearance of a carcinoid tumour showing the well marked stroma. (Haem. and Eosin × 200)
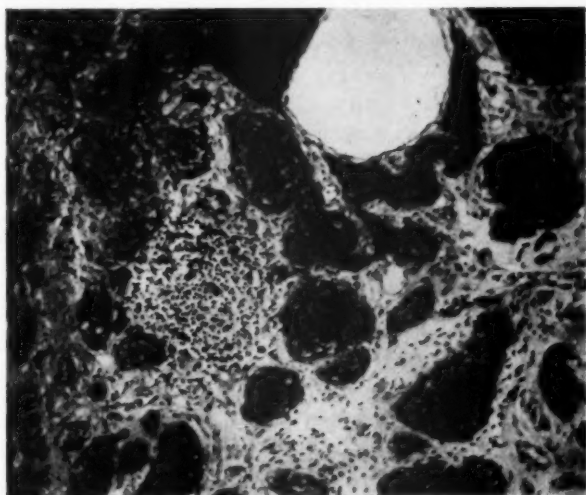
Fig. 6. A vessel in the meso-appendix being infiltrated by growth. (Haem. and Eosin × 110)
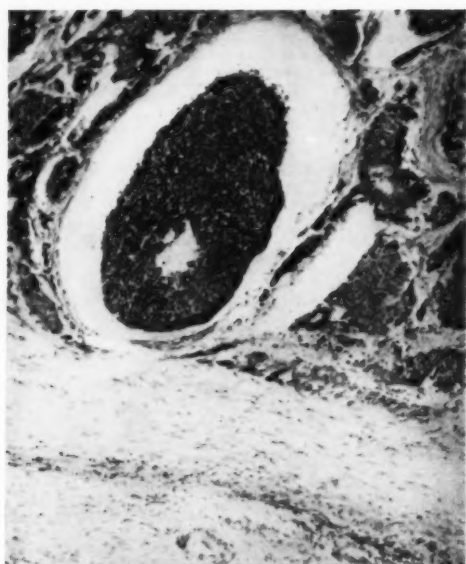
Fig. 7.   An omental vessel containing tumour. (Haem. and Eosin × 95)

sented with intestinal obstruction.   So that you can see the tendency to regard them as silent and symptomless is false.

The commonest symptoms are those of abdominal pain, diarrhoea and, in certain cases, flushing attacks.

The abdominal pain can be due to many causes.   Obstruction is the commonest, particularly in the small gut tumours.   This may be due to its intra-luminal size, with the annular and polypoid types, or to extrinsic pressure by a mass of malignant glands.   However, the commonest type of lesion, a plaque in the wall of the bowel, is unlikely to give rise to obstruction.   It may rarely act as the apex of an intussusception.   Obstruction does result from the plaque-like lesions for, as they infiltrate the mesentery, the fibrous tissue reaction I showed earlier is produced.   This causes an angling or kinking of the gut, leading to obstruction.

Acute appendicitis may be caused by the pressure of a tumour.   This is particularly likely to occur with those situated in the middle or at the base of the appendix.   The commonest site, however, for tumours in the appendix is at the tip, where they are unlikely to obstruct the lumen.

Colicky abdominal pain may occur with no apparent obstructive element.   This is due to the local release of 5 H-T by the tumour causing spasm and hyperactivity of the intestinal muscle.   The apparent muscle

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hypertrophy in the gut wall may be due to this repeated stimulating action. Raiford (1933) does not believe that this is a true hypertrophy but only a connective tissue hyperplasia.

Diarrhoea is a most common and distressing complication of the disease. It can reach such proportions that it is completely crippling. One of my patients had, at times, to have his bowels open eighteen to twenty times a day. This is the symptom that worries them most, and it seems to be resistant to treatment, for the usual medical remedies fail to control it. It is very unusual for these patients to pass blood for, as I mentioned earlier, the tumour is sub-mucous and even the larger lesions do not ulcerate.

Finally, I would like to describe the flushing attacks. These patients always have permanent skin changes in the face with telangiectases over each cheek and the bridge of the nose. Their flush varies considerably in frequency and intensity. It can be precipitated by the ingestion of food, drink, particularly alcohol, emotion or by the mechanical means of massaging the secondary deposit. We have used this latter method in the film to produce the flush. The patient has subjective sensations of varying intensity during the duration of the attack. They complain of a feeling of heat, a fullness in the head, sometimes giddiness, gut colic and often an urgent desire to micturate. Some patients have asthmatic-like attacks during the period of flushing, or occasionally at other times. All these symptoms are due to 5 H-T over-activity and can be reproduced in normal subjects if a sufficiently large dose is injected intravenously.

The flushing starts in the face, which becomes deep red. At this stage the blood pressure may fall slightly, and the pulse rate starts to rise. The vasodilatation spreads rapidly down the neck over the trunk and to the arms. The distribution is patchy, varying in size from a few millimetres to several inches in diameter. There is variation in colour from bright turkey red to mauve, with intervening areas of pallor. The cyanotic areas do vary greatly, and we believe that their presence is related to the room temperature. On cold days the cyanosis predominates, whereas on warm days, or under arc lights, the cyanotic areas may be completely absent. As the flush develops in the trunk it starts to fade from the face. There is a marked temperature gradient between the red and white areas, differences of 4 to 9 deg. C. have been recorded. With the development of the flush the pulse rate continues to rise to levels of 130 to 140, and the blood pressure also rises well above the pre-flush level. A variable tachypnea develops which may lead to an asthmatic-like attack of moderate severity. After a few minutes the flush starts to fade, and in the majority of cases has completely disappeared in ten minutes, but the patients are left feeling tired often with an associated headache. However, sometimes a patchy flush will last for many hours, but the unpleasant subjective sensations are only of short duration in the initial stages of the attack.

If the onset of a flush is carefully observed, the patch can be seen to start as a web of dilated vessels which soon disappear into a diffuse redness.

The flush has the appearance of a very much exaggerated triple response reaction without the wheal formation and the itching. Pernow and Waldenstrom (1957) were able to extract abnormal quantities of histamine from the urine of several of their patients with this syndrome. As 5 H-T is a known histamine liberator, they suggested that this was the mechanism of the flushing. In our patients and many of those reported in the literature there has been no increased urinary histamine excretion. Further work has shown that if sufficiently large quantities of 5 H-T are injected intravenously into normal subjects, a carcinoid-like flush of transient nature develops. The explanation of this vascular phenomenon is still unknown. Some malignant cases do not develop flushing at any time, and how these patients differ from those with flushing has not been explained.

The lesions affecting the valves of the heart are by far the most significant part of the syndrome when determining the prognosis. Even with widespread hepatic deposits the patients survive for many years. Those with the flushing syndrome die from heart failure. I know of one patient with a carcinoid tumour of the bile and pancreatic duct with extensive hepatic metastases who has survived for twenty years. Most workers believe that the valve lesions must, in some way, be related to the high blood level of 5 H-T. This would explain the higher incidence on the right side of the heart. Unsuccessful attempts have been made to reproduce these lesions in rats by chronic administration of 5 hydroxytryptophan. This substance was used because 5 H-T would have been destroyed so rapidly.

TABLE VI

Cases with flushing syndrome	..	..	..	..	..	..	..	..	37
Cases with proven valve lesions		..	..	..	..	..	..	..	22
Pulmonary valve ..	..	..	..	..	..	..	..	..	22
Tricuspid valve ..	..	..	..	..	..	...	..	..	15
Aortic valve	..	..	..	..	..	..	..	..	3
Mitral valve	..	..	..	..	..	..	..	..	3

The pulmonary valve is most commonly affected. There is usually a cuspal stenosis with thickening and rolling of the valve margins. Cases have been reported in which similar types of lesions have been found in the smaller pulmonary arteries (Fig. 8).

The tricuspid valve is also commonly affected. The usual lesion is tricuspid incompetence due to contraction of the papillary muscle and chordae tendinae. Changes do occur in the valve edge which becomes beaded and thickened. Cases have been reported where this change has predominated, leading to tricuspid stenosis (Fig. 9).

The aortic and mitral valve lesions are interesting. They are most uncommon, being produced by some mechanism that allows sufficient

Fig. 8. Pulmonary valve showing early stenosis.

5 H-T to reach the left heart blood.   There are two possible causes ; first the presence of pulmonary metastases, and secondly the presence of a patent foramen ovale (Fig. 10).

On microscopy of the valve the only abnormality appears to be a deposit of poorly staining fibrous tissue on the surface. In the adjacent valve endocardium there may be an increase in the number of mast cells (Fig. 11).   The changes are certainly unlike those of rheumatism or syphilis. It has been suggested that these changes were due to an alteration in cell permeability with platelet deposition, fibrosis, and ultimate re-organization.   Whatever the cause may be, we do know that the lesions progress rapidly, leading to heart failure and death within about six years of the onset of the flushing attacks.   One of our patients had a phono-cardiogram in 1954 which showed changes of tricuspid incompetence. Three years later she had developed marked pulmonary stenosis, and she is now suffering from congestive heart failure.

A final change that I would like to mention is the voiding of pigmented urine.   These patients will, on some days, pass urine that, on standing in light for a few minutes, becomes burgundy coloured.   The pigmentation is thought to be due to the formation of an ox-indole between the 5 H-T. 5 hydroxy-indole acetic acid stage of metabolism (Rimington, personal communication).   This is borne out by the observation that on the days that the pigmented urine is passed, the excretion of 5 hydroxy-indole acetic acid is very much depressed, even to normal levels.

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Fig. 9. Tricuspid valve showing the changes in the valve margin and areas of endocarditis.

Diagnosis

Before the recognition of the flushing syndrome, the correct pre-operative diagnosis was hardly ever made. In routine investigations, such as barium studies, there is nothing that is pathognomonic of the tumour. Miller and Herrman (1942) were able to demonstrate the "kinking effect," described earlier, during a barium "follow-through," and made the correct pre-operative diagnosis. However, the chances of being able to demonstrate this sign are not very great.

Since the syndrome has been recognized as a definite entity, the correct pre-operative diagnosis is being made more frequently. There are numerous laboratory methods for estimating the urinary 5 hydroxy-indole acetic acid excretion, and also chromatographic techniques are
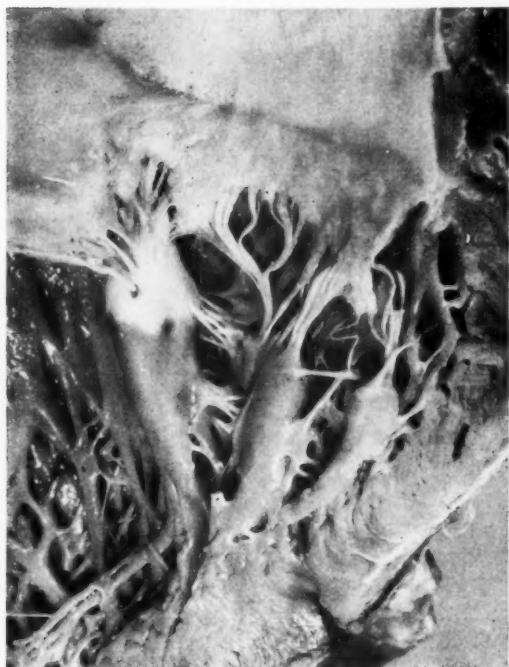
Fig. 10. Early changes in the mitral valve with capping of the papillary muscle.

frequently used. These are easier and more accurate tests to perform than the more complicated pharmocological or chemical methods for estimating the 5 H-T level in the blood.

TREATMENT

Surgical

The treatment of choice is still that for any malignant lesion, that is wide resection of the primary growth and removal of the local lymphatic field if technically possible. If, however, the lesion is not identified, or not even seen, as with appendicular carcinoids, the future management presents some difficulty. We believe that here we must rely entirely on the pathologist's findings. If the tumour has reached the limit of section of the meso-appendix or mesentery, or the lymphatics or blood vessels are involved, then a " second look " operation should be undertaken. At this procedure, if the glands look suspicious, then resection, or in the case of the appendix a right hemi-colectomy, should be performed. This may seem a drastic procedure to adopt for a lesion that is of relatively low grade malignancy, but nevertheless in our opinion it is warranted.

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Grimes and Bell (1949) compared the survival times of patients with small gut carcinoids treated by different operations. They found that wide resection gave a survival time of eight and a half years, bypass four years and biopsy without bypass less than twelve months. Even in the presence of a hopelessly inoperable growth as long as obstruction is prevented the survival time is of reasonable duration.

At operation another, and more acute, difficulty may arise during the anaesthetic. 5 H-T is a powerful broncho-constrictor and at operation high blood levels may be obtained by manipulation of the tumour mass during mobilization. We have found that these patients may develop a broncho-constriction which resists both ether and pethidine. The safest anaesthetic appears to be an epidural, and on empirical grounds it may be of advantage to combine this with pre-operative preparation with chlorpromazine, which is a 5 H-T antimetabolite. A suggested mode of action of the epidural anaesthetic is that the local anaesthetic is absorbed into the circulation, producing broncho-dilatation and secondly there is a reduction of venous return preventing the development of pulmonary hypertension.

Radiotherapy

The results from the use of radiotherapy have been disappointing. The majority of reports show no beneficial effect that can be attributed to the
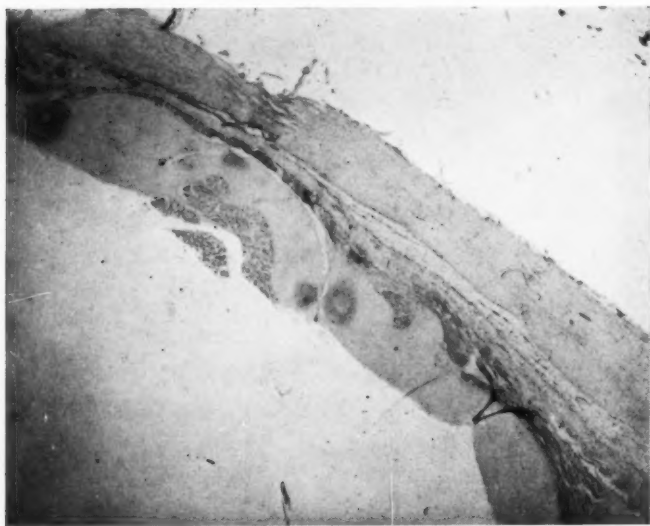
Fig. 11.   Tricuspid valve.   (Haem. and Eosin × 10)

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treatment. Radio-active gold has been used in one patient with hepatic secondaries (Goble, *et al.*, 1956). She showed symptomatic improvement with reduction in the flushing and diarrhoea, and with a diminution in the excretion of 5 hydroxy-indole acetic acid. This effect was due to the radio-active gold being absorbed into the reticulo-endothelial system of the liver, permitting of almost direct interstitial irradiation of the malignant cells. However, it is unlikely that this method could be used therapeutically.

Antimetabolites

A great deal of work has been carried out on the use of antimetabolites of 5 H-T in the treatment of the flushing syndrome. The object of the treatment is to produce symptomatic improvement by reducing the frequency and intensity of the flushing attacks and diarrhoea, and to prevent or stop further progress of the valve lesions. Really it is only a form of palliation but, as we have seen, these patients can survive for prolonged periods as long as valve lesions do not develop.

Certain of the antimetabolites that are active in animal experiments could not be used because of physical and psychic side-effects. Adrenochrome produces hallucinations, and yohimbine is a powerful aphrodisiac and could not be used for obvious social reasons. The ergonovine group of which lysergic acid, diethylamide (L.S.D.) and ergotamine are representative members, are powerful antimetabolites in experiment. Both these substances have been tried without any symptomatic improvement. The L.S.D. does produce hallucinations and also unpleasant subjective side-effects. Professor Rothlin prepared a brominated derivative of this substance (BOL 148) without these side actions, and only producing tranquilization. We have used this substance in doses of 1 to 10 mgs./day without any success.

Investigating a series of compounds called methyl serotonins, Dr. Woolley of New York synthesized 1 Benzyl 2.5 dimethyl serotonin (B.A.S.). He found that it was the most powerful antagonist of 5 H-T that he had yet seen in animal experiment. We have used this substance in amounts up to 150 mg./day in divided doses without symptomatic improvement. Other workers (Schneckloth, *et al.*, 1957) have used doses up to 400 mgm./day without any effect. It has, however, in common with some of the other antimetabolites, a marked tranquilizing action. This substance is now being assessed by the psychiatrists as a possible addition to their growing list of tranquilizers.

Another antimetabolite is chlorpromazine. The early reports from America claimed that there was marked symptomatic improvement in patients with the flushing syndrome, as well as decrease in the excretion of 5 hydroxy-indole acetic acid (Cole and Bertino, 1956). We have repeated this work without success, either symptomatically or biochemically. It has now been found that the decrease in urinary 5 hydroxy-indole acetic acid excretion is only apparent, and is due to a direct quenching of the colour reaction by the cholorpromazine.

The use of antimetabolites of 5 H-T seems to have failed. An alternative approach was to prevent the formation of 5 H-T by interfering with the metabolic pathway. In phenylketonuria the level of 5 H-T is depressed (Pare, *et al.*, 1958). This is thought to be due to the circulating aromatic acids interfering with some part of the enzyme system, possibly the 5 hydroxy-tryptophan decarboxylase. One of these acids, phenylacetic acid, is known to be safe for oral administration up to 15 grams per day (Sherwin and Kennard, 1919). This substance has been used in the treatment of five patients (Sandler, *et al.*, 1959). There was no constant symptomatic improvement, although one patient had a marked reduction in the frequency of flushing attacks and bowel actions during a short course of treatment. In this patient the course was repeated with the introduction of placebo tablets without repetition of the previous symptomatic relief. It seems likely that this improvement was not significant, and was probably psychological in origin, for we do know that the flushing attacks can be influenced by emotion. There was no marked reduction in the twenty-four hourly excretion of 5 hydroxy-indole acetic acid. If, however, the hourly excretion was estimated after a dose of 5 grams of phenylacetic acid was given, there was a significant reduction starting in the fourth hour and continuing for several hours (Fig. 12). Quite clearly the phenylacetic acid does reduce the 5 H-T formation, but its effect does not seem to be sufficiently powerful to produce symptomatic improvement. It may be that the drug is not readily absorbed, and does not reach the more inaccessible tumour tissue.
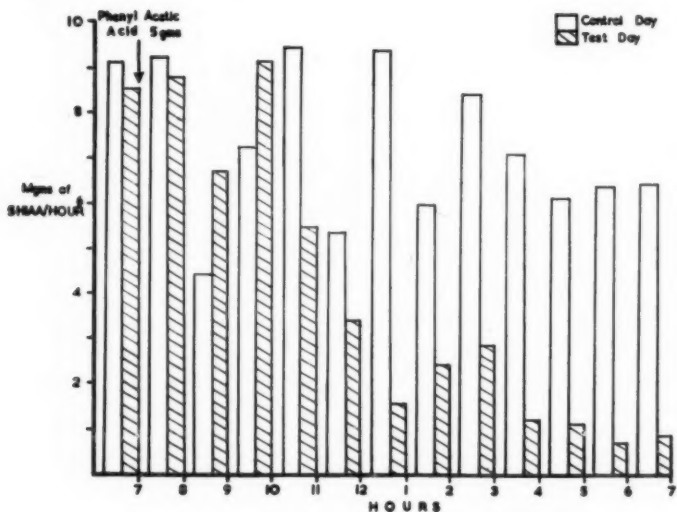
Fig. 12. The hourly excretion of 5 HIAA after phenyl acetic acid administration.

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Symptomatic

Tryptophan is concerned with nicotinic acid formation. Sixty per cent. of the tryptophan intake is deviated to form 5 H-T in cases of carcinoidosis, that is thirty to sixty times the normal amount. These patients might well develop pellagra which could account for some of the symptoms, particularly the mental changes. Thorson *et al.* (1954), were able to improve the pellagrinous-like skin lesions occurring in one of their patients with large doses of nicotinamide. In addition to a high protein intake it would seem advisable to implement the diet with nicotinamide.

In the terminal stages of the disease these patients develop electrolyte imbalance due to the severe diarrhoea, congestive heart failure due to the valve lesions and marked mental changes. These all have to be corrected by the appropriate medical means. The diarrhoea is particularly difficult to manage, for it resists most of the usual medical remedies.

CONCLUSION

In this lecture I have attempted to present a complete picture of carcinoid tumours with the relevant background of the histological appearance of the argentaffin cell and the physiology of 5 H-T. The most important point that emerges from this study is that, if the flushing syndrome does not develop, these patients can survive for many years, even with widespread metastases. The more tumour tissue that is removed at operation, the less likelihood there is of developing the syndrome. I believe even if this requires massive resection or, perhaps, hepatic lobectomy, it is worth considering.

The treatment with anti-metabolites does not seem to have given the good results that were expected from it. However, the drug phenylacetic acid has shown that biochemical improvement is possible. Perhaps by increasing the dose or modifying the structure of this substance so that it is more readily absorbed, symptomatic relief may also be obtained.

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BLEEDING FROM
GASTRO-OESOPHAGEAL VARICES

Cecil Joll Lecture delivered at the Royal College of Surgeons of England

on

10th October 1957

by

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THE DILATATION OF the veins in the stomach and oesophagus is merely a part, though a very useful part, of the changes that take place to establish a collateral circulation when the portal vein is obstructed. The channels which enlarge in the retro-peritoneal tissues at the ano-rectal junction and in the falciform ligament also serve a useful purpose, but the present
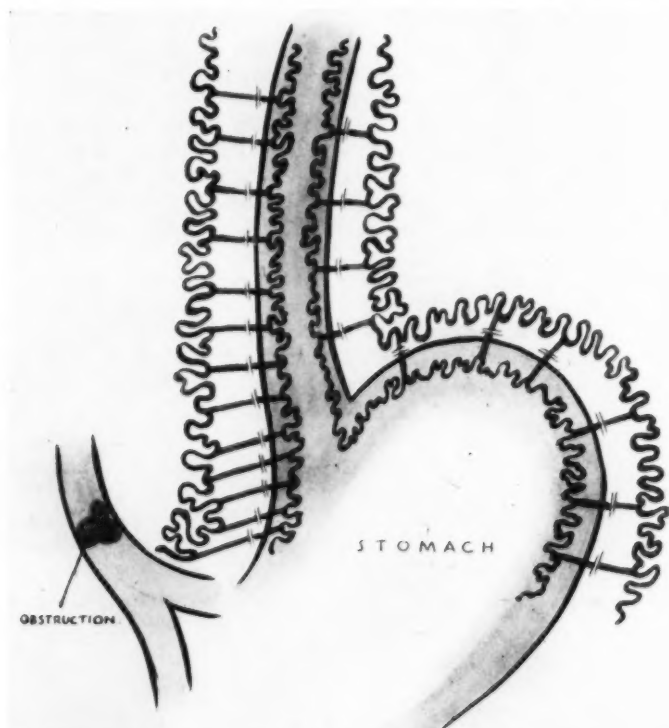
Fig. 1. Diagrammatic representation of the submucous venous plexus of oesophagus and stomach and branches communicating with the plexus in the mediastinum and extra-peritoneal spaces. The points of division of these branches and the obstruction of the portal vein are indicated.

paper is concerned only with those which pass up the mediastinum to the vena azygos and its tributaries. These last are in two main planes, the submucous layer of the stomach and oesophagus, and the extraperitoneal and mediastinal plane. These two groups of veins communicate with one another freely by short thick tributaries which pass through the walls of the stomach and oesophagus. Although these communications are found at all levels, nowhere are they more numerous than at the cardiac end of the stomach and adjacent part of the oesophagus (Fig. 1). Whilst all these veins are not only compensatory but essential to the maintenance of the portal circulation, and whilst any of them may, from time to time, cause symptoms and even death, those in the submucous layer of the stomach and oesophagus are such a menace to life that their existence could hardly be justified if other channels were adequate to carry the portal blood back to the heart. It is therefore important that the surgeon should view his problem as a whole. He has to deal, not with a disease, but with Nature's best effort to remedy the ill effects of disease. Whilst trying to eliminate those distended veins in the submucosa that imperil the patient's life, he must just as assiduously strive to preserve all other channels that contribute to his survival. The shortness and the width of the communicating veins between the two sets of vessels make the fulfilment of this aim difficult, tedious and time consuming, but it is the basis of an operation which I have practised now for some years. Much has already been written about the relief of tension in the portal system, and more particularly the diminution in the flow of blood in established collaterals by the anastomosis of the portal vein to the inferior vena cava. That this can be a most effective operation is proved beyond doubt. It is not necessary or even possible to compare the relative merits of different operations for the relief of the symptoms of portal hypertension. The surgeon must have all the skills at his command and adopt the one most suited to the occasion ; for the portal and splenic veins may be patent or thrombosed ; the spleen may already have been removed ; bleeding may occur from the stomach or the oesophagus ; the patient may seek advice because of repeated bleeding, or he may be admitted moribund from loss of blood ; liver function may be good or grossly impaired, and ascites, too, may be present. Certainly there are many patients in whom a porto-caval anastomosis is either impossible on physical grounds, or inadvisable because of liver damage, and to these the surgeon must have something else to offer. The least that can be said of the operation to be described is that it is useful in these circumstances ; and in the small series presented, the results do in fact compare well with those of porto-caval shunt.

Surgeons differ as to why varicosities bleed in the stomach or oesophagus, and it is not uncommon to blame the digestive action of the gastric secretion. It may well be that gastric digestion is occasionally the final precipitating factor, but it is certainly not always a necessary

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one. Varices bleed because they are tortuous. The friction of the
blood passing round the curves wears away the wall of the vein and the
covering mucosa until this becomes so thin that its nutrition is impaired
and it ulcerates. The process is exactly comparable with varicose
ulceration of the skin of the leg. It is the presence of an ulcer with its
surrounding reaction that makes the bleeding so dangerous, for this
keeps the hole in the vein open. Needle puncture of distended veins
in the oesophagus may cause a little bleeding, but not so much as to
endanger the patient. It has been done repeatedly with large bore
needles for the measurement of pressures in the veins, and has never led
to any trouble or anxiety (Allison, 1951). The reason for this is undoubt-
edly that the walls of the vein and the mucosa are still soft enough to
close the puncture hole whereas in spontaneous bleeding the hole is kept
open. All collateral channels become tortuous when they have to carry
more blood than is normal. North (1958) has shown experimentally that
increased blood flow is a stimulus to hypertrophy of either artery or vein,
and that the vessel increases in both width and length by an increase in
the number of cells in its walls. As it increases in length it must become
tortuous. In most places in the body this tortuosity hardly matters
because the vessel is supported externally but evidence of the process of
erosion may be clearly seen in the ribs of patients with coarctation of
the aorta. Where the vessel is submucous, however, its covering will
only last so long as its attenuation falls short of necrosis. Beyond this
point bleeding is inevitable. A simple corollary of this argument is
that when a patient has once bled from gastric or oesophageal varices
it is certain that bleeding will recur until it causes death. The length of
survival after the first haemorrhage has been variously estimated by
different authors. Snell (1950) found that after one year 80 per cent.
were dead and Patek's (1952) corresponding figure was 50 per cent.

There is therefore a compelling indication for surgical treatment.

With the above considerations in mind the following operation has
been performed since 1948, originally as a first choice, but latterly in
those patients where porto-caval anastomosis was impossible because
of portal vein thrombosis or inadvisable because of liver damage.

A left thoraco-abdominal incision is made, starting at the outer edge
of the left rectus abdominis muscle and extending across the costal
margin to the spine over the eighth rib. The eighth rib is removed and
the pleura and peritoneal cavities opened. Special care is taken with
haemostasis as there may be greatly increased blood flow through the
intercostal veins as part of the collateral circulation. From the divided
costal margin the diaphragm is split back toward but not into the oesopha-
geal hiatus, the phrenic veins being sutured where they are cut, and the
stitches either left long for traction or passed through the intercostal

muscle and tied. The development of the collateral channels in the chest and abdomen is noted and a liver biopsy taken.

In many patients the spleen has already been removed for bleeding on some previous occasion. If the portal vein is thrombosed or if some other contraindication to porto-caval shunt exists in the presence of the spleen, then the spleen should be removed. It is fully appreciated that the removal of the spleen predisposes to portal vein thrombosis, but, so far, no adequate reason has been advanced for the retention of the spleen other than the need to keep the portal vein patent for a possible anastomotic operation, and when the vein is already occluded the spleen is better removed.

A point on the greater curvature of the stomach is chosen corresponding with the union of the left and right gastro-epiploic vessels, and all the vessels entering and leaving the stomach between here and the oesophagus are divided between ligatures as close to the gastric wall as possible.

The greater curve of the stomach is then reflected forward to expose the posterior surface and all the vessels here are similarly treated. At the bare area of the stomach the vessels become very numerous indeed.

The arteries and veins of the lesser curvature are secured over the area corresponding to the distribution of the left gastric artery. Some of these are best approached from the posterior aspect of the stomach and some from the front. To secure all these vessels close to the wall of the stomach without injuring the mass of extro-gastric collaterals requires care and patience.

The oesophagus is isolated in the mediastinum above the point at which any large vessels are seen to enter it. Tape is passed round it for traction, and all the communicating structures, whether they be arteries, veins, or nerves, are divided on the oesophageal wall so that it is, as it were, filleted from its bed. Some of these communicating trunks between the mediastinal and submucosal plexus are very short and wide, and it is difficult to isolate and divide them without tearing. Some of the vessels at the cardia are divided from below with slight traction on the stomach and some from above with traction on the oesophagus. Inevitably the fascial attachments of the cardia are injured. They must be repaired and reinforced with silk stitches to ensure the normal competence of the cardia after operation. In one early patient in which this was not done regurgitation and peptic stenosis occurred later. The completion of this stage of the operation leaves the lower half of the oesophagus and the upper half of the stomach completely free of any external attachments apart from their continuity above and below. It is from the ends only that blood reaches or leaves the isolated parts.

The operation is completed by a longitudinal incision in the muscular wall of the oesophagus just above the diaphragm and by the separation

of the mucosa from the muscle and the drawing out of the mucosal tube from its bed (Figs. 2 and 3). The vertical venous channels are very closely adherent to the mucosa and they must be either isolated and divided or understitched with fine catgut. If the mucosa is very atrophied over a tortuous vein it may be impossible to isolate the vein without entering the lumen of the oesophagus. Such openings are not important so long as the pre-operative toilet of the oesophagus has been

STOMACH

Fig. 2. Incision of the muscular wall of the oesophagus above the cardia with exposure of the varices in the submucous layer.

adequate and the holes are carefully sutured. The mucosal tube is returned to its bed and the muscle incision sutured over it. The mediastinal pleura is left widely open and the diaphragm closed with interrupted silk covered on its pleural aspect with continuous catgut. The thoraco-abdominal incision is closed with an underwater drainage tube in the pleural cavity. The tube is left in place for twenty-four hours.

If the necessity for preserving the external collaterals is accepted as being almost as important as the isolation and interruption of the submucosal collaterals, and this is indeed the basis of the procedure, then it is unlikely that the operation can be performed in less than five to six hours. Over the years, occasional modifications have been introduced, as for example, a circular incision round the muscular wall of the oesophagus was used at one time for the exposure of the submucosal veins, and this was later changed to a longitudinal incision, but the basic principle and design of the operation has remained unchanged.

Fig. 3. The tube of mucous membrane and varices withdrawn intact from its muscular bed.

It was hoped at one time to do a control series treating alternate comparable cases by porto-caval shunt and by devascularization, and indeed such a series was started. The times involved and the changes of staff and location have made it impossible to complete such a series, and it seems likely that only by the co-operation of a number of surgeons doing similar work in different centres could a significant series be obtained for comparison. The Table summarizes the results.

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Name and Age	Aetiology of Portal Hypertension	Length of Freedom from Bleeding	Fate	Remarks
F.G. 49 years	Cirrhosis of liver	6 years	Death from astro-cytoma	No varices found at post-mortem.
A.F. 53 years	Cirrhosis of liver	2 years	Death from liver failure, jaundice and haemoperi-toneum	Developed peptic stricture of oeso-phagus.
J.B. 24 years	Cirrhosis of liver	8 years	Alive and well	
J.R. 27 years	Cong.syphilitic cirrhosis	5 years	Alive and well	Developed ascites
W.H. 29 years	Cirrhosis of liver	6 years	Alive and well	
G.D. 33 years	Cong.syphilitic cirrhosis	9 years	Alive and well	Treated for bleed-ing piles success-fully.
R.H. 29 years	Cirrhosis of liver	9½ years	Alive and well	
Z.J. 14 years	Portal vein thrombosis	6 years	Alive and well	Bled after 6 years. Further devascu-larization and now well 3 years.
M.G. 40 years	Cirrhosis of liver	—	Operative death. Mesenteric thrombosis	
B.C. 15 years	Portal vein thrombosis	7 years	Alive and well	
N.N. 9 years	Portal vein thrombosis	5 years	Recurrent bleeding in another hospi-tal	
B.H. 27 years	Cirrhosis of liver	4 years	Alive and well	Operation for perf. ulcer.
F.N. 56 years	Haemochromatosis	—	Operative death from necrosis of stomach	Marked athero-sclerosis of coeli-ac and mesenteric vessels.
A.C. 14 years	Thrombosis of portal vein	5 years	Alive and well	
M.H. 5 years	Thrombosis of portal vein	3 years	Recur. haemate-mesis.	
N.A. 33 years	Cirrhosis of liver	8 years	Alive	Recur. ascites.
B.K. 4 years	Thrombosis of portal vein	4 years	Alive and well	
J.B. 12 years	Thrombosis of portal vein	1 year	Recurrent haema-temesis	
N.I. 40 years	Cirrhosis of liver	2 years	Alive and well	
J.H. ? years	Cirrhosis of liver	1 year	Alive and well	

Out of twenty patients operated upon two died as a direct and immediate complication of operation, one died from an unrelated cause after six years freedom from bleeding, one died from liver failure and haemo-peritoneum after two years and the remaining sixteen are alive. Of these sixteen patients three must be considered as failures because bleeding recurred after five, three and one year respectively, one a partial failure inasmuch as bleeding recurred after six years, but after re-operation the patient remained well, and the remaining twelve can be thought of as

successful in so far as they have remained free from bleeding to date, five of them for over eight years.

Nothing more can be claimed for this operation than that it can be considered as an alternative to porto-caval anastomosis; that it can be used where porto-caval anastomosis is impossible or has failed; that it is not complicated by metabolic disturbances or deterioration in the condition of the liver and that in an important proportion of the patients who have started the downhill run of severe haematemesis it offers the prospect of prolongation of life and freedom from bleeding.

It has the added attraction that it can be applied to those children in whom the portal vein is obliterated and in whom anastomotic operations are either impossible or unsatisfactory. Its disadvantage is that it is more difficult.

During the period in which these devascularization operations were done, twenty-nine porto-caval anastomoses were performed. Of these five died as an immediate result of operation, four died within four months, one bled again within four months of operation and nineteen had remained free from bleeding for between one and four years.

A direct comparison of these figures with those for devascularization is not possible because they are too few and too recent and many of the devascularizations were done for patients who had already had their spleens removed, or who had obliterated portal veins from other causes.

CONCLUSION

1. The cause of bleeding from varices is atrophy of the covering mucosa due to friction of blood passing through tortuous channels.

2. Collateral vessels are tortuous because of the increase in length as well as breadth, and this is a response to increased blood flow.

3. Collateral varices are all useful, but those in the submucosa are a danger to life because the lack of supporting tissues renders them liable to ulceration and bleeding.

4. When bleeding from oesophago-gastric varices has once occurred it recurs until it proves fatal.

5. Where for one reason or another porto-caval anastomosis is impracticable or inadvisable an operation designed to direct the flow of blood from the submucosal venous plexus should be considered.

SUMMARY

1. The aetiology of oesophago-gastric varices is discussed.

2. An operation for the relief of bleeding from these veins is described.

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CONGENITAL DEFORMITIES OF THE HAND

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A CHILD WITH a congenital deformity of the hand differs from an adult who loses part of his hand as the result of accident or disease. The child has never known the use of a normal hand and, until becoming self-conscious of his appearance, makes every effort to keep up with his fellows at home and at school. He develops ingenious trick-movements to utilize every available scrap of tissue. Even in severe deformities, these patients may achieve excellent function.

Sir Charles Bell, in his lectures on the hand in 1834, quoted the case of the beggar of Moscow : " a man who from birth had no arms . . . had committed many murders before he was discovered and executed. This wretch . . . took his stand on the highway some miles from Moscow, on the skirts of a wood. His manner was to throw his head against the stomach of the person who was in the act of giving him charity, and having stunned him, to seize him with his teeth and so drag him into the wood ! "

The excellent function in most of the congenital deformities of the upper limb has led to the view that surgical treatment should be limited to the separation of webbed fingers and the removal of supernumerary digits. Recent advances in the technique of reconstruction of the hand have made it seem valuable to re-assess these cases.

Case material

The case records of 600 congenital deformities of the hand were studied. The majority of these had been seen at the Hospital for Sick Children, Great Ormond Street, and comprised nearly all the cases referred to that hospital in the twenty years from 1937 to 1957. With this background of the pattern of these deformities 200 patients were selected and examined. These were chosen as far as possible from the more severe types of deformity, and from the older children and adults. The function of the deformed hand was assessed by the patient's account of his disabilities, with particular reference to ordinary domestic tasks, his progress at school and comparison with his fellows, and his work and hobbies. Other congenital deformities, either in the same limb, or elsewhere, were noted. Simple clinical tests were then used to demonstrate the main functions of the hand, and the results in treated and untreated cases were compared.

The objects of this investigation were to find out which types of case would benefit from treatment and, by studying the function in adult life,

to be able to give a prognosis to parents who bring a deformed infant for consultation.

CLASSIFICATION

No comprehensive classification of congenital deformities of the hand exists. Study of these cases shows the pattern which runs through them, and an attempt has been made to provide a classification based on the function of the hand. One anatomical feature of the deformity will usually be found to interfere predominantly with the full use of the hand. If cases are grouped according to this feature, the degree of the deformity can be traced from mild to severe through each of six groups :

    (1) Webbing of normal fingers.
    (2) Webbing of abnormal fingers.
    (3) Abnormalities of position.
    (4) Absence of parts.
    (5) Ring constrictions.
    (6) Excess of tissue.

Most of the cases are mild and require no treatment, but this classification means that there is one treatment-problem for each group. Cases can be assessed on one aspect of what may be a complicated deformity, different treatments can be compared and some sort of prognosis given. The fact that this method approaches a purely anatomical classification shows how closely function is related to structure in the congenitally deformed hand.

Figure 1 shows two patients with syndactyly, but one has skin joining fingers which are otherwise normal, and the other has skin joining fingers which are short, weak and stiff. The prognosis is quite different in the two cases and it is impossible to compare methods of treatment. The first case presents the technical problem of forming a supple skin-lined cleft which will not contract as the child grows. In the second case indiscriminate separation of fingers may produce a hand whose individual fingers are weak and stiff, and which may be weaker as a whole than before treatment. Since syndactyly is the commonest single deformity, and is often associated with more complicated deformities, it is important to distinguish two groups. In Group 1 the fingers are normal apart from the skin, and the prognosis is good. In Group 2, although webbing of the fingers may be the most prominent feature, the underlying skeleton is abnormal. Separation of the webs may have little effect on function, and the prognosis is determined by the skeletal abnormality.

Group 1. Webbing of normal fingers

In Group 1, the middle and ring fingers are most commonly joined (Fig. 1a), and males are more often affected. The condition is often bilateral and symmetrical, and the toes are webbed in 18 per cent. of cases (Davis and German, 1930). There is sometimes a strong family history.

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It is rare to find fingers which have a true web. Usually the fingers are bound closely together by a skin-bridge which extends in the mildest form to the proximal inter-phalangeal joint and in the severest to the tips of the fingers. The full-length of the fingers is most commonly involved. The nails may then be joined and there may be bony fusion between the terminal phalanges. This means that the terminal inter-phalangeal joints will be opened when the fingers are separated. These cases are really on the border-line between Groups 1 and 2, since there may be residual deformity due to abnormality of the terminal joints.

Fig. 1.

(a) Webbing of normal fingers (Group 1). (b) Webbing of abnormal fingers (Group 2). The small, webbed hand.

Group 2. Webbing of abnormal fingers

The small webbed hand, which is the commonest type in Group 2, is usually unilateral and is rarely inherited (Fig. 1b). The toes are unaffected. Associated deformities are common, and the whole upper limb is usually smaller than the other side. In the more severe degrees, the central rays are less well-formed, and the hand comes to resemble the lobster-claw type of deformity (Fig. 9a). Alternatively, there is a progression towards greater fusion of parts, until the hand is reduced to a solid mass, and bone must be divided when the digits are separated. This reaches its most severe form in acro-cephalo-syndactyly, the syndrome first described by Apert in 1906. Feet and hands are similarly affected, and there is a characteristic deformity of the skull (Fig. 2).

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Fig. 2.   Acro-cephalo-syndactyly.   (Group 2.)

Group 3.   Abnormalities of position

In the third main group of hand deformities are the abnormalities of position.   These are either flexion contractures or lateral displacements (Fig. 3).

(a)   Flexion contracture

In the flexion deformities, there will again be found a gradation of cases from mild to severe (Figs. 3a, b, c).

The normal infant holds his fingers and thumb flexed into the palm for the first few weeks of life.   For this reason, many of these deformities are not noticed until some time after birth.   During this time the fingers can be passively straightened, and the baby can be seen to extend them occasionally before clenching them again.   With the mildest form of contracture, some force is required to straighten the fingers, and on release they spring back into the palm.   The baby cannot straighten them spontaneously.   More severe cases resist passive stretching and there is obvious contracture of the structures in front of the metacarpo-phalangeal and interphalangeal joints.   In a single finger this is commonly seen as the congenital contracture of the little finger, which is often bilateral and hereditary.   The thumb alone may be affected, or several fingers to a varying degree.   The contracture of the thumb should be distinguished from the commoner " trigger-thumb."   In the worst cases, flexion of all the fingers is accompanied by ulnar deviation.   This is the " talipes-hand " described by Denis Browne (1939) (Fig. 3 b).

The more generalized forms of contracture may involve all four limbs (Fig. 3c).   The condition is then known as arthrogryposis or amyoplasia congenita, but it seems probable that all these cases represent different degrees of the same process.   There is a failure of differentiation of muscle as well as contracture of ligaments and joint-capsules.   Characteristically

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the elbows are extended and the wrists flexed, pronated and deviated to the ulnar side. The fingers and thumb are flexed into the palm. The knees are extended and the hips flexed. There is only a very small range of movement at all joints.

(b) Lateral displacement

The lateral deformities may be limited to the fingers (clinodactyly). Minor bony and joint abnormalities cause deviation of one or more fingers, usually to the ulnar side (Figs. 3d, e).

Deviation at the wrist, causing club-hand, is very much commoner to the radial than to the ulnar side (Fig. 3 f). Radial club-hand is usually associated with absence of the radius, although deviation of the hand may occur when the radius is intact. The radius may be completely absent or there may be a small fragment at the upper or lower end. Complete

Fig. 3. Abnormalities of position. (Group 3.)
(a) Flexion contracture of one finger. (b) Flexion contracture of all fingers with ulnar deviation. (c) Arthrogryposis. (d) Lateral deformity of one finger. (e) Lateral deformity of all fingers. (f) Radial club-hand.

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absence occurs in half the cases, of which half are bilateral. The angulation at the wrist varies from 30deg. to 90deg. or more. There is contracture of all the soft tissues on the radial side, and the unopposed pull of the long flexors rotates the hand into full flexion and pronation. Associated abnormalities are common. The ulna is short, curved and thick. The hand and arm are small, and the shoulder-girdle is usually under-developed. There may be deformities of the ribs and absence of pectoralis major and other muscles. In the hand the radial artery is often absent and the radial nerve may end at the elbow. he fingers may be thin and stiff, and the thumb and first metacarpal absent (O'Rahilly, 1951).

In all these cases in Group 3, it is the abnormal position which interferes with function. The prognosis depends on the success of treatment by manipulation, splinting and, occasionally, surgery in improving the position.

Group 4. Absence of parts

The fourth group, absence of parts, is a large one (Fig. 4). On the radial side of the hand there are a number of abnormalities confined to the thumb. The thumb may be weak due to failure of development of the thenar muscles. This has little effect on the function of the hand. More severe is absence of the first metacarpal, which produces a flail thumb (Fig. 8). The thumb and first metacarpal may be completely absent (Fig. 4a). There are then commonly abnormalities of the carpus on the radial side and a frequent association with absence of the radius and radial club-hand.

On the ulnar side, there may be absence of the ring and little fingers and their metacarpals : this is occasionally associated with deformities of the ulna (Fig. 4c). Kanavel (1932) used these types of case as the basis of his theory that there is a longitudinal pattern in all deformities of the hand, which involves either the radial bud or the ulnar bud, and their derivatives.

In the centre of the hand there are the lobster-claw deformities. Classically the central ray, represented by the middle finger with its metacarpal, is missing (Fig. 4b), but it is commoner to find the central three rays deformed and the fingers reduced to blobs of soft tissue (Fig. 9a). As the deformity becomes more severe the thumb and little finger become progressively reduced until one or both are absent.

All digits may be rudimentary or absent (Fig. 4d), the carpus and forearm absent, or the hand may articulate directly with the shoulder-girdle due to failure of formation of the humerus and forearm ; this is the phocomelus, so called because of the resemblance to the flipper of a seal (Fig. 4e). Finally, there are rare cases of total absence of the limb or limbs (Poidevin, 1953) (Fig. 4f).

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All these cases are sometimes referred to as congenital amputations, although there is no evidence to support the older theories of an extrinsic factor such as pressure from a band or the umbilical cord, and it is now generally held that they are due to agenesis or failure of development.
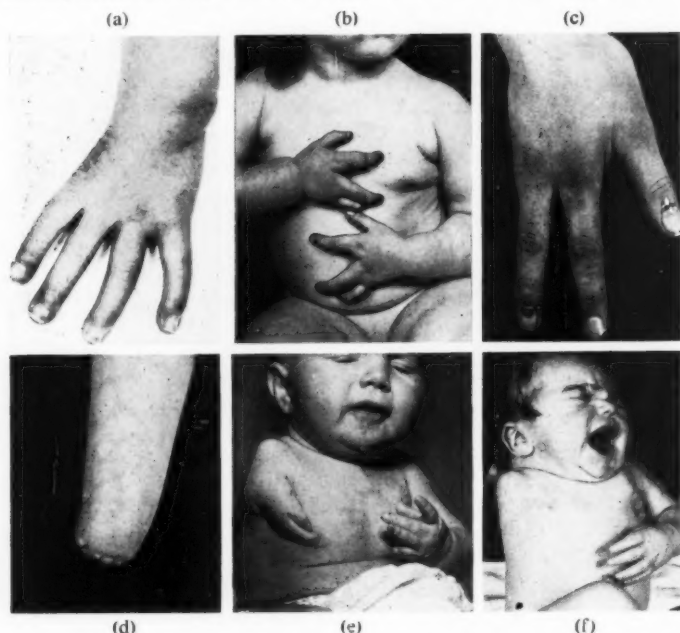
Fig. 4.   Absence of parts.   (Group 4.)
(a) Absence of the thumb and first metacarpal. (b) Bilateral " lobster-claw."
(c) Absence of ulnar digits. (d) Agenesis of the hand. The digits are represented by blobs of soft tissue. (e) Phocomelus. (f) Absence of the upper limb.

Children with these severe deformities develop compensatory movements.   The pattern is similar in all children, although some work out highly ingenious methods.   One small girl with agenesis of one hand was able to thread a needle by licking the thread, smacking it down on the stump so that the end protruded slightly and threading the needle over it with the normal hand.   Girls knit by holding the needles under their arms, and boys discover ways of holding implements using the sleeve of the shirt.   With a long stump it is possible to steady a cricket-bat or hockey-stick.   Teeth are used for manipulating buttons.   A skipping rope is held by knotting one end round the stump.   Shoe laces and bows are tied by locking the first loop with a half knot; this holds it steady while the second loop is made.   Finally, in gross deformities of the upper limbs, the feet and toes are used, and the mouth plays an important part.

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The prognosis of all cases in this fourth group depends on the extent of the missing parts, and the possibility of replacing them by surgery or prosthesis.

Group 5. Ring constrictions

Group 5 consists of a number of varied conditions which make up the ring constriction syndrome (Fig. 5). These cases are uncommon; there were 30 in this series of 600 hand deformities. Their bizarre appearance and frequent association with amniotic bands have led to many speculations upon their aetiology. It has often been suggested that the band is the extrinsic cause of the deformities. Streeter (1930) showed that it is more likely that both the deformities and the amniotic bands are the result of the same developmental failure. He found no evidence that a band is ever the cause of a deformity. Even if the aetiology is uncertain, an attempt may be made to describe the mechanism. Again the cases are graded from mild to severe.
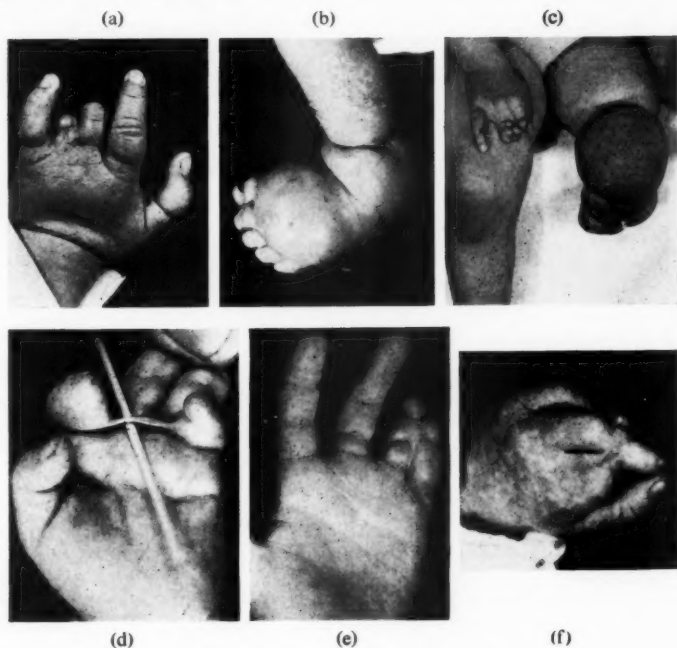
Fig. 5. Ring constrictions. (Group 5.)
(a) Ring constrictions of thumb and little finger. There is an epithelial tunnel between ring and middle fingers. (b) Deep ring constriction above the ankle with oedema of the foot. (c) Intra-uterine amputation of left leg below the knee. There is a ring constriction of the thigh. (d) Band joining the index and little fingers. (e) Fenestrated syndactyly. (f) Fusion of the soft tissues of several fingers.

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The ring constrictions themselves, like other deformities of the hand, are commoner towards the periphery of the limb (Fig. 5a). Usually shallow, they may be ulcerated at birth. In the deepest grooves, bone is exposed, and there is oedema and sometimes disorganization of the distal part (Fig. 5b). The final stage is the true intra-uterine amputation forming a conical stump on which rudimentary digits are never found (Fig. 5c). There seems no doubt that ulceration frequently occurs in these cases in utero, and that it is usually healed before birth. There may be fibrous bands running from one raw surface to another and to the amnion (Fig. 5d). Adjacent fingers may be fused by the healing together of raw surfaces—a process similar to that seen in a burnt hand if the fingers are not dressed separately. The fusion may be over a small area towards the tips of the fingers. If a larger area is involved, a characteristic epithelial tunnel remains to mark the base of the cleft. This is the terminal or fenestrated syndactyly (Barsky, 1951) (Figs. 5a and e). Finally, there are multiple fusions, although here again only the soft tissue is involved, and it is possible to separate these fingers without dividing bone (Fig. 5f).

Group 6. Excess of tissue

In Group 6 there is excess of tissue, either excessive number of parts (polydactyly), or excessive size of parts (gigantism) (Fig. 6).

(a)   (b)

(c)
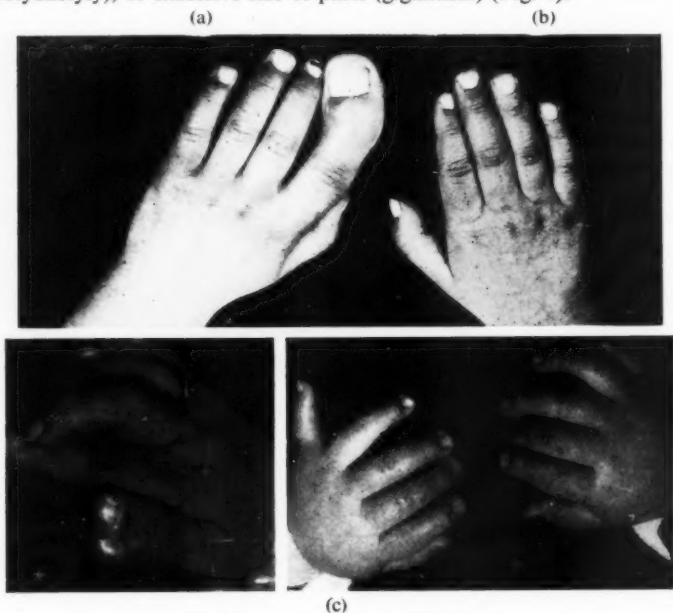
Fig. 6. Excess of tissue. (Group 6.)
(a) Polydactyly. (b) Reduplication of the terminal phalanx of the thumb.
(c) Gigantism—megadactyly.

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(a) Excessive number of parts. Polydactyly

Some form of duplication of a digit is the commonest single anomaly after webbing of the fingers, and ranges from a minute tag to a fully-formed digit or digits. Thirteen digits have been recorded on one hand (Barsky, 1951). Polydactyly is commonly inherited and occurs so often in one Arabian tribe that five digits are regarded as a deviant. The extra digit, which is often rudimentary, is usually marginally placed and commonly bilateral (Fig. 6*a*). On the ulnar side small skin-tags without bone are common. On the radial side the rudiment usually contains bone (Fig. 6*b*). The larger digits are often webbed to the adjacent finger. In the severest forms there may be almost complete duplication of the limb, the thumb being replaced by an accessory hand which is set at right-angles to the normal palm—the " mirror-hand " (Mukerji, 1956).

(b) Excessive size. Gigantism

Cases of gigantism follow the general pattern of hand deformities. The abnormality is greatest towards the periphery ; in a single digit the terminal phalanx is the largest part (Fig. 6*c*). The whole limb may be affected and be larger in all dimensions than the opposite side. More commonly only one or two digits are affected, usually the index and middle fingers, the metacarpals being normal. They may be webbed into one large mass. In addition to the increase in size there is also distortion of the fingers which becomes more marked with growth, so that in adult life the finger is grotesquely bent, and the joints undergo early arthritic changes which make the fingers painful and useless. All tissues are present in larger quantities than normal, but are of normal appearance. On dissecting these fingers the subcutaneous tissue is increased in proportion more than the skeleton, but there is no evidence of a haemangiomatous or neurofibromatous element.

GENERAL CONSIDERATIONS

There are certain points which should be taken into consideration in the general management of all deformities of the upper limb.

1. Deformities in other systems

As in all congenital deformities there may be involvement of other systems. In this series a small number of children died of multiple congenital anomalies which included limb deformities. Other serious anomalies may influence the decision to undertake treatment, and may mean that the child can only be properly cared for in an institution, when the limb deformity by itself would have allowed attendance at a normal school. Defective intelligence prevents the child making full use of the limb and lessens his co-operation in treatment.

2. Abnormalities in the same limb

In the same limb there may be deformities of the chest and shoulder-girdle. In congenital absence of muscle, the pectoralis major is most

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frequently affected (Adams, Denny-Brown and Pearson, 1953). As an isolated deformity it is usually the costal heads of origin which are missing —rarely the whole muscle (Fig. 7a). Approximately 25 per cent. of these cases have an abnormality of the upper limb on the same side ; either a general diminution in size or a deformity of the hand only (Brown and McDowall, 1940). It is interesting that the hand deformities are nearly always of the same type—the small webbed hand or, less commonly, the lobster-claw. All other types of hand deformity have normal chest development, except some cases of gross agenesis and radial club-hand, often bilateral, where the shoulder is severely affected, and the pectoralis is only one of several missing or anomalous muscles (Fig. 7b).

Fig. 7.
(a) Absence of the costal heads of pectoralis major associated with a small, webbed hand on the same side. (b) Bilateral radial club-hand with severe abnormalities of the whole of the upper limbs.

In twenty-four consecutive cases of small webbed hand in this series, there were twelve with absence of the costal heads of pectoralis major, and in seventeen cases of lobster-claw, three with absence. The deformity of the chest was always on the same side as the hand deformity. All the girls who had a hand deformity and absence of the pectoralis major had under-development of the breast on that side. Absence of the pectoralis major causes very little disability. There is a characteristic fibrous band and skin-web running from the chest to the arm (Fig. 7a). Rarely, this limits abduction and has to be lengthened.

At the shoulder, shortening of the limb, as in failure of development of the humerus, causes difficulties with personal toilet which can be largely overcome by the suppleness of the back.

At the elbow, there may be radio-ulnar synostosis. The forearm is fixed in pronation. If the shoulder is normal it will compensate for this, and the disability is slight.

Minor abnormalities of the carpus are comparatively common, usually fusion of two adjoining bones which does not interfere with function.

3. Local conditions in the hand

With regard to the local condition in the hand, parents are often hopeful that the deformed part will "catch-up" with the normal side as the child grows. This does not occur. Deformed limbs continue to grow but remain in proportion. If a new-born infant has, for example, a single digit which is too short to oppose effectively to any part of the hand, it can be stated that that digit will always be too short.

All deformities are commoner towards the periphery of the limb. Only in the mildest cases is the abnormality confined to one tissue. The worse the deformity, the greater are the changes in surrounding tissues or in the whole limb. There are always defects of the soft parts which correspond roughly to the bony defect. Joints may be stiff, and muscles and tendons rudimentary ; nerves and vessels are misplaced. These widespread abnormalities may prejudice the results of major reconstructive surgery.

4. The timing of surgical treatment

The timing of surgical treatment is important. Some cases, mostly abnormalities of position, benefit from manipulation and splinting as soon as possible after birth. It has also been suggested that early operative treatment is necessary for two reasons. Firstly, that unless the deformed parts are freed and put into their correct positions, there will be secondary atrophy of muscles and stiffening of joints (Kelikian and Doumanian, 1957). Observation of the cases in this series, however, makes it seem more likely that these muscle and joint abnormalities are part of the original deformity.

Secondly, since the child quickly develops abnormal movements to compensate for certain types of deformity, surgical treatment should be carried out before the pattern becomes firmly established. But this abnormal movement is often efficient, and can not be improved by surgery. In other cases, mostly where parts are missing, the child has had no chance to develop even an abnormal pattern. The child with a single digit which will not oppose to the rest of the hand has never been able to imitate a gripping movement. If an opposition post is constructed, he quickly learns to make full use of a new technique.

In very young children the technical difficulties of operations and postoperative splinting are increased. There is the danger of damage to growing parts. For these reasons, there are few indications for reconstructive operations in infancy. The timing in most cases will be governed by the school age of five. It is desirable that treatment shall be completed by that age and that the child's hand is then in the form that it will remain for the rest of his life.

5. The importance of sensation

The importance of the hand as a sensory organ must always be borne in mind. Covering the hand with a prosthesis will interfere with this, as

will reconstruction with skin flaps from a distance. If flap cover is required, the operation can often be planned to shift sensitive hand skin over tactile areas, either by a local flap, or by " filleting " a useless digit, and to cover the less important defects by a graft from another part of the body.

6. The place for prostheses

The use of prostheses in congenital deformities of the hand is controversial. Artificial arms are unsatisfactory compared with artificial legs. The urge to walk is so strong that an infant will make full use of an artificial leg and achieve excellent function. An artificial arm is heavy and clumsy, and reduces the sensory area of the hand. The child can often only be persuaded with difficulty to keep it on, and great patience and ingenuity are required by parents and limb-fitters. The prostheses have to stand up to heavy wear and tear, and require frequent replacement as the child grows. They have, however, an important place in the management of certain types of deformity.

The limb-fitting surgeons are prepared to fit a simple " dress " type of artificial hand as soon as the intelligence of the child warrants it, and this may be as early as two or three years of age. The child wears the hand for short periods at first, and gradually increases the time. There are advantages in having the pattern established before he goes to school. It is important that the prosthesis should be adapted to incorporate the limb, however deformed. Formal amputation is rarely necessary and may deprive the child of a part of the limb which he finds useful. Stump troubles do not occur in these congenital deformities.

The " dress " hand requires no training in its use. A spring attachment may be incorporated in the thumb to allow light objects to be held, but children find that they can manage very well by wedging things between the fixed, artificial fingers. The more specialized attachments, of which the split-hook is the most useful, are fitted later and require training, which is carried out during residence at a limb-fitting centre. Most adult patients only wear their limbs for work or on social occasions, and children only wear them at school. When they are at home the limb is taken off. Boys who use extra attachments for carpentry and other school activities leave the working hand at school, and travel to and from home wearing a " dress " hand.

Prostheses are also important from the cosmetic point of view. Most adolescents will ask for some disguise for the more severe types of deformity.

7. The appearance of the hand

In any discussion on hand injuries or deformities, restoration of function rightly takes first place. But the problem of the appearance of the hand becomes more important as the child grows older. At first he is unselfconscious, and remains so for a variable time, depending on his management at home and the comments of his school-fellows. Sooner or later, usually at puberty, he becomes ashamed of his deformity and adopts

all sorts of ruses to prevent strangers seeing his hand, often spending most of the day with his hand in his pocket. The psychological disturbance is, perhaps, no worse than the upset that may occur in any adolescent with a disfigurement, but it has been surprising to find how widespread it is in all these hand deformities, and what adverse effects it has on the use of the hand and the response to treatment.

The effect that treatment may have on the appearance of the hand is important at all stages. These patients may be willing to sacrifice function in return for improved appearance. Girls will not wear a split-hook prosthesis, preferring the more natural-looking dress hand. One young woman with an unsightly but useful hand, for several years never left the house without an elaborate dressing of wool and bandage, which covered the hand completely, and which she used to tell her friends was the result of an accident. Then she met a young man who said that he was not a bit interested in the appearance of her hand ; she never wore the bandage again, and finally married him.

The reaction of a child to his deformity is largely determined by the attitude of his family. Parents may try to conceal the deformity, and to do things for the child when he is clumsy or slow. It is important that he should not be treated differently from other children. Normal independence is best developed by allowing him to make his own way among a large family or at school. A few children who are severely handicapped may have to go to special schools, but the majority derive great benefit from a normal school. It is one of the main objects of treatment to fit these children for normal schooling at the normal age.

DETAILS OF TREATMENT

Some of the details of treatment in each of the six groups will now be considered.

Group 1. Webbing of normal fingers

In group 1, syndactyly has in the past acquired a reputation for poor response to treatment. The fingers may become contracted and distorted by scar tissue, and the condition may recur as the fingers grow and pull skin forwards from the hand.

Since a true skin-web is very rare, when the fingers are separated there is a large defect, which no local flap operation can make good. When a skin-graft is laid into this defect in one piece, the continuous U-shaped scar may contract. There is always enough local skin to form a gusset at the base of the cleft, which will break the line of this scar. In designing this it is important to remember that the normal cleft extends further on to the dorsum of the hand than on to the palm.

Operation may be carried out when the child is about four years old, unless a long finger is joined to a shorter. If the long finger is distorted, they should be separated as soon as possible, although there is often permanent deformity in these cases, due to an underlying abnormality in the finger. When three fingers are joined, only one cleft should be made

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at a time.   Exposure of both sides of a finger at the same operation may interfere with the blood supply to the tip.   Free skin-grafts do not grow as fast as the rest of the hand, and careful follow-up is required to ensure that contracture does not occur.   The thicker the graft, the less the tendency to contract.

Group 2. Webbing of abnormal fingers

In the second group, webbing of abnormal fingers, the prognosis for the function of the hand depends more upon the skeletal deformity than upon the webbing (Fig. 1b).   In many of these cases the configuration of bones and joints prevents the fingers reaching a full span, and division of the webs has little effect on movement.   If these webs are divided routinely, some patients will be left with stiff, unstable fingers in the centre of the hand. The blood-supply to these fingers is often abnormal, and there may be circulatory trouble when they are separated.   In spite of careful after-treatment the grafts may contract.   These fingers add little to the function of the hand, and may be an encumbrance, but patients and parents are strongly opposed to their amputation.

Some hands in this group, with a mild skeletal deformity, will give good results if the webs are divided and grafted in stages with care not to expose both sides of a finger at one operation.   In the majority, however, operation should be postponed beyond the usual age, until clinical and radiological evidence show that an individual digit is likely to be stable after separation.   The more severe types tend towards the lobster-claw deformity (Fig. 9a).   The central rays are reduced, and the child uses the ulnar side of the hand for pinch-grip with the thumb.   Once this habit is established, it is not worth while trying to build up the index finger.   It is better to concentrate on strengthening the ulnar digit if this is unstable.

In many cases the separation of abnormal webbed fingers is requested for cosmetic reasons.   Division of the webs may not make the fingers any more useful, but the hand looks better, and it is possible to wear a glove and a wedding-ring. The longer treatment is postponed, the less will be the risk of stopping growth by arthrodesis of small joints which become unstable.

(a) Webbing of the thumb

The thumb is differentiated before the fingers, so that it is only rarely webbed to the rest of the hand.   The web is often slack, and it is possible to estimate the degree of movement that will be obtained by freeing the thumb.   Correction of this deformity requires the establishment of a well-lined cleft.   This can best be done by raising a flap of skin from the back of the hand which will wrap round the thumb when it is freed ; a large piece of skin is required to allow the thumb to oppose without tension.   The defect on the back of the hand is covered with a free graft.

(b) *Acro-cephalo-syndactyly* (Fig. 2)

In acro-cephalo-syndactyly, all the digital bones and joints are abnormal but it is always worth while attempting some separation. These patients have to use a two-handed grip to pick up anything, and the construction of even a single, relatively immobile, cleft allows objects to be wedged in, with a great increase in function.

Group 3. Abnormalities of position

(a) *Flexion contractures*

(i) Congenital contracture of the little finger

The commonest example of the flexion deformities is congenital contracture of the little finger. Here there is occasionally obvious skin shortage. Division of this at an early age allows passive stretching to be carried out with some improvement. More commonly there is contracture of all tissues, including the capsule, on the front of the proximal inter-phalangeal joint. Often there is a deformity of the bone-ends forming this joint. It is always possible to relieve skin tension by a Z-plasty or free graft, but even after extensive dissection little improvement is gained. This deformity rarely interferes with the function of the hand although it may cause some difficulty in putting on a glove.

(ii) Contracture of all fingers

There may be contracture of thumb and fingers which is often not noticed at birth. In the milder cases, they can be straightened passively, but spring back into the palm on release, and the baby cannot straighten them. These cases benefit from splinting straight on simple aluminium strip splints for a few weeks, followed by night-splinting for several months. If the fingers can be straightened passively and held straight during the early weeks of life, the prognosis is good and a normal hand results.

In most of the severe cases, which resist passive stretching, the contracture persists and the children grow up with a permanent deformity (Fig. 3b). With fixed flexion and ulnar deviation of the fingers, vigorous stretching or manipulation under anaesthetic may make the condition worse, and it is better to rely on gentle stretching and night-splinting which the mother can be taught to do at home.

These hands lack full power but are otherwise quite useful in adult life.

(iii) Trigger-thumb

Trigger-thumb is often present at birth. It may not have been noticed by the parents, and a diagnosis of fracture or dislocation is usually made when the child is later found to be unable to straighten his thumb (Apley. 1956 ; Wilks, 1956). The terminal phalanx is held flexed and a nodule is palpable on the flexor tendon. In infants the thumb is much more commonly affected than the fingers, and a " click " on forced extension is not found as it is in adults. The treatment is to slit the flexor sheath

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opposite the metacarpo-phalangeal joint as soon as the condition is recognized. This produces an immediate cure, and recurrence is very rare.

(iv) Arthrogryposis

In the more generalized forms of flexion contracture, arthrogryposis, all four limbs are usually involved (Fig. 3c). There is only a very small range of movement at all joints. Manipulation and prolonged splinting may produce some improvement, but relapse is common. Hand splints may interfere with the use of crutches. Most of these children are completely crippled and have to be looked after in special institutions.

(b) Lateral displacement

(i) In the group of lateral displacements, the milder forms involving one or more fingers, rarely cause interference with function, and no treatment is required (Figs. 3d and e).

(ii) **Radial club-hand**

Radial club-hand is a comparatively common deformity to which a great deal of attention is now being given, in an attempt to overcome the many problems which it presents.

One of the main disabilities is lack of power in the fingers. The greater the deviation at the wrist the more relaxed are the forearm muscles, and the less effective are the fingers in strength and range of movement (Riordan, 1955) (Fig. 3f). However, even when the thumb is missing the stiff fingers may give an adequate grip for normal activities. The most powerful movement which these patients possess takes advantage of the fixed radial deviation of the hand. The limb is used as a hook. Straightening the wrist removes this powerful action which they use for all heavy lifting and carrying.

Owing to the widespread changes in the limb, treatment is difficult (Fig. 7b). Prolonged splinting from early life improves the position temporarily but adds little to the function. When the child starts to use the limb actively, the splint becomes an encumbrance, and many parents discard all splints as they find that the child can manage better without. The deformity may, however, be progressive. The pull of the long flexors rotates the hand from radial deviation into full flexion and pronation, and may eventually bend the ulna. If this pull is unopposed extreme contracture of the soft tissues occurs.

Entin and Petrie (1957) have recently laid down principles for the management of these cases. Splinting is started as early as possible with light wire and elastic splints, which do not interfere with the use of the hand ; these are maintained for six or eight years. If the hand cannot be straightened, the soft tissues on the radial side are lengthened. At the age of eight an autogenous graft of the proximal half of the fibula is wedged into the ulna, forming a buttress for the carpus. Osteotomy of the ulna may be required if bowing persists or gets worse. Arthrodesis of the wrist is postponed until the hand is fully grown, so that growth is not

impaired. They stress that this programme gives good results when the hand is normal.

There were no patients in the present series in whom attempts at straightening, other than by splinting, had been carried out, but the widespread abnormalities in the limb make it clear that the prognosis must always be guarded. Straightening the wrist will improve function when the fingers are normal, but in many cases the fingers are stiff and imperfectly formed. These patients then rely on the deformed position of the hand for their most powerful movement.

Group 4. Absence of parts

Group 4 contains many of the deformities for which reconstructive surgery may be carried out.

(i) Absence of the first metacarpal

On the radial side of the hand, absence of the first metacarpal causes instability of the thumb (Fig. 8). The phalanges, which are covered by skin of good texture and sensation, may themselves be malformed or rudimentary. They are connected to the hand by a pedicle of varying thickness. This pedicle, which is characteristically attached more distally than the normal thumb, sometimes to the side of the proximal phalanx of the index finger, may be so slender that it readily undergoes torsion. The digit becomes congested and may atrophy.

Fig. 8. Absence of the first metacarpal.

In stabilizing such a thumb, a preliminary operation is required to enlarge the pedicle and set it further up the hand. The vessels which it contains are tenuous and may be damaged at this stage, or later due to excessive tension in the pedicle when a bone graft is inserted. This is a

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hazard of attempting to stabilize flail digits in any part of the hand. When the phalanges of the thumb are well-formed and supplied with tendons, replacement of the missing metacarpal with a bone graft gives good results. More commonly, however, the bones and tendons are poorly developed and the best that can be provided is a rigid post placed in a position to allow contact with the index finger.

(ii) Absence of the thumb

Children compensate for total absence of the thumb by developing an accurate pinch-grip between the index and middle fingers. A strong grip is possible between the pad of the middle finger and the nail of the index. Often a considerable degree of rotation of the index occurs, so that the cleft between them is opened up. Boys find no difficulty in handling a cricket-bat or carpentry tools; knives and forks present no problems. There is very little disability from absence of one thumb if the other is normal. Once these compensatory movements are established, the child will continue them and refuse to make use of a rigid thumb post. He may even find that the post gets in the way.

There is therefore no indication for reconstruction of a thumb by pollicization or any other method if the other hand is normal. It should be taken into consideration here that a four-finger hand looks natural; the absence of the thumb is not immediately apparent to a casual glance (Fig. 4a). In bilateral absence of the thumb, reconstruction on one side may be carried out by pollicization of the index. This gives good results when the index itself is normal. However, bilateral absence of the thumb is often associated with serious deformities in the rest of the limb, particularly of the radial club-hand type, where the fingers are stiff and malformed (Fig. 7b).

(iii) Absence of ulnar digits

Absence of digits on the ulnar side of the hand has little effect on function. The ring and little fingers with their metacarpals may be absent, while the rest of the limb is normal (Fig. 4c).

(iv) Lobster-Claw deformity

With the central ray defects, or lobster-claw, function is usually excellent. Central rudimentary digits are nearly always useless and may be removed to allow a better grip between the radial and ulnar digits (Fig. 9a and b). These patients develop a good grasp and an accurate pinch-grip. Sometimes it is possible to increase the span and allow larger objects to be grasped by deepening the cleft. If skin lengthening only is required a Z-plasty gives good results. X-ray will show whether it is possible to remove bone in the centre of the hand without interfering with the function of the remaining digits.

In the severer degrees of this deformity, the radial and ulnar digits may also be rudimentary or flail. Early in childhood it can be decided how much opposition movement is possible between these two digits. If they will not oppose, even if lengthened, reconstruction will not produce

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(a)   (b)
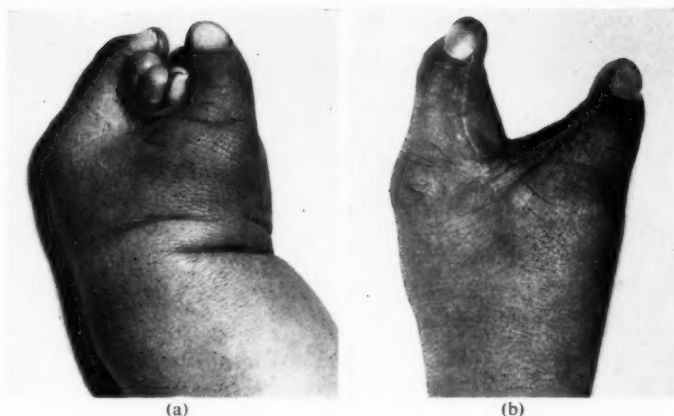
Fig. 9.

(a) " Lobster-claw " with three rudimentary central digits. (b) The result of deepening the cleft.

a worth-while increase in function. There is little to be gained by adding an immobile peg to the hand. If opposition is possible, lengthening one digit may allow some sort of grasp. Here it is essential to preserve the sensation of the gripping surfaces, which means that local hand skin should be used for the reconstruction whenever possible. When the radial and ulnar digits are rudimentary and there is no possibility of reconstructing an opposition mechanism, wedges of wood or cork may be made of such a size that they can be held ; into these can be fixed tools, and knives and forks.

The lobster-claw is a particularly unsightly deformity, and occasionally patients will request that the cleft be obliterated. This can only be done at the expense of the span of the hand. Although the adult who has a central finger amputated through the metacarpo-phalangeal joint may complain that small objects slip through his grasp, this does not occur in the congenital lobster-claw. Narrowing the cleft may be done by excision and suture of the margins. A considerable amount of skin must be removed, and deep stitches are required in the region of the trans-verse metacarpal ligament. Even with careful post-operative treatment it is difficult to prevent the cleft spreading again. In the lobster-claw deformity of the foot this is a worth-while operation which will often allow a normal shoe to be fitted, but in the hand cases must be very carefully selected.

(v) The single digit

With more severe failures of development, excellent function may still be achieved. With one opposing digit on each hand, the child can keep up with his fellows at school and, in adult life, earn his living by work

Fig. 10.
(a) One opposing digit on each hand.   (b) Both hands are used to hold a pen.

involving exceptional manual skill.   The boy illustrated in Fig. 10,
aged 14, keeps well up with his class at a secondary modern school.   He
plays cricket, and his hobbies are carpentry and pottery.   His younger
sister, with a similar deformity, is top of her class and plays all games ;
her needlework has been commended by the head-mistress.   Their
father, who is the only other member of the family affected, earns his
living as a sign-writer on glass.   All three hold a pen in both hands
(Fig. 10b).   It has been repeatedly noticed that patients with severe
hand deformities tend to choose those hobbies and occupations which
require a high degree of manual dexterity.

These patients are successful because the digit which they possess is
capable of opposing to the rest of the hand.   With increasingly severe
deformities there comes an abrupt change.   With one opposable digit
function may be nearly normal ; if the digit is stiff, or flail, or cannot be
made to oppose to any other part, function is grossly diminished.   If the
single digit present is mobile, every attempt should be made to build
an opposition post by skin-flap and bone-graft.   Here the " cocked-hat "
flap, described by Gillies and Millard (1957) is of the greatest value, allow-
ing the bone graft to be covered by skin of normal hand sensation.   A
single short digit, for which it is not possible to build an opposition post,
can be incorporated in, and made to work against, a prosthesis, or even
to activate part of it.

(vi) Absence of all digits

Absence of all digits is comparatively common and is always unilateral
(Figure 4d).   Children with this deformity are characteristically strong and
highly intelligent.   They soon learn to do most things for themselves and
to keep up with the rest of the family.   In all their activities the agenetic
hand is actively used to pin down objects.   Any small, stable bony pro-
jection is therefore some advantage, allowing greater accuracy.   But the
difference in function between those who have such a projection and those

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whose stump is rounded is so slight that any attempt to lengthen one edge of the stump surgically is not justifiable.

These children find it difficult to cut the nails of the normal hand, but can manage a nail-file. Many of them deliberately keep the nails short by biting them. They have to have their food cut up for them ; this is a source of great embarrassment at school. All patients with this deformity, if asked what they can do, reply : " everything, except cut up my food." In adolescence, and often before, the child will ask for a disguise for this deformity. With the standard " dress " hand a very satisfactory grip for a knife or fork can be made by wedging the implement in between the artificial fingers. Children with such a prosthesis are therefore at no disadvantage. Since they will all require a dress hand in adolescence they should be fitted with artificial hands before they go to school.

(vii) Gross failures of development

Some of the deformities in this group are so severe as to have made it impossible in the past for a patient to earn his living except by exhibiting his deformities. Involvement of all four limbs may necessitate education at a special school. The worse the deformity, the greater are the abnormalities in the parts of the limbs that remain. This means that there are only rare indications for major reconstructive operations, such as toe-transplantation. It is usually possible to fit some modification of the standard artificial arm, and the limb-fitting surgeons in this country have found that results are better with this than with any form of Krukenberg or cineplastic procedure (McKenzie, 1957). The more severe the deformity of hands and arms, the greater the importance of feet and mouth. Children with absence of the upper limbs, who have learned to use their feet, will not persist with attempts to wear clumsy prostheses.

Group 5. Ring constrictions

There are a few special points in the treatment of cases in the ring constriction group.

The shallower rings themselves are treated for appearance only ; they tend to become less obvious as the child grows. Excision of the groove, with everting suture of skin and subcutaneous tissue on either side, may be sufficient, but this circular scar sometimes contracts to produce a recurrence. A better result is obtained by using transposition flaps of Z-plasty type.

The deepest grooves are associated with lymphoedema of the distal part, which is often relieved by dealing with the ring as described. There seems no doubt that lymphatic drainage can be re-established into the proximal part of the limb. The swelling may be much improved, but in severe cases there is always an underlying deformity in the distal part (Fig. 5b).

The fenestrated syndactyly is often of such mild degree that the small band joining the tips of the fingers can be divided and the raw areas closed by suture. More marked fusion of fingers requires division and

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graft ing as forordinary syndactyly ; a probe passed through the epithelial track at the base conveniently marks the commissure (Fig. 5a).

Group 6.   Excess of tissue

(a)   *Excessive number of parts*

The supernumerary digit may project rigidly and interfere with the use of the hand, but more often treatment is for the sake of appearance. When the digit is small it is easily removed, the only precaution being to ensure that no part of an epiphysis is left behind to cause recurrence by further growth.   If a supernumerary digit of any size articulates with a phalanx or metacarpal, neither it nor the normal digit are in the correct axis with the proximal bone (Barsky, 1958).   It is sometimes difficult to decide which is the normal part.   This difficulty arises most frequently in the thumb.

Reduplication of part of the thumb is one of the commonest congenital deformities of the hand, and is the commonest form of polydactyly (Fig. 6b).   The deformity varies from a tag on a normal distal phalanx to an almost symmetrical splitting of the thumb.   The radial half is usually the smaller although both are abnormal if they articulate with a common metacarpo-phalangeal joint.   When the thumbs are nearly symmetrical it is difficult to decide which one to remove ; as a general rule it will be found that the more radially placed digit should be removed.   Exploration under a tourniquet may be required to determine the precise arrangement of tendons, but often clinical examination is enough.   The dissection must be done with care, to leave as much of the joint capsule as possible, by dissecting out the digit subperiosteally.   The capsule should be repaired and the joint splinted.   Even with all precautions the remaining thumb may not be completely straight and may be unstable. It may be thought that it would be better to leave these thumbs alone, but the older patients with deformity following operations for this condition have little or no disability. If required, the joint may be arthrodesed when growth is complete.

(b)   *Excessive size*

In cases of gigantism, where one finger is affected, it may be sufficient to remove excess soft tissue, or to amputate the terminal phalanx to bring the finger to a more normal size.   These fingers grow faster than the rest of the hand and when they exceed the size of the equivalent adult fingers, it will have to be decided whether they should be amputated.   Attempts to arrest growth when the optimum size has been reached have not been successful.   It has seemed too hazardous to use irradiation, and mechanical destruction of the epiphyses is difficult and uncertain.   Since these fingers all become distorted and painful, amputation may be the only possible treatment.

AETIOLOGY OF CONGENITAL DEFORMITIES

The parents of children in this series were questioned about incidents in pregnancy which might have influenced the occurrence of deformities.

This retrospective method is unreliable ; there is a natural tendency for a mother to look for some cause when she has given birth to a deformed infant. In most cases the incidents occurred after the seventh week of pregnancy, by which time the hand is already formed. The prospective method recently described (McDonald, 1958) gives more valuable information. A note is made, during ante-natal examinations, of all incidents occurring in early pregnancy. These mothers are then followed-up and the number of deformities recorded.

Observation of the anatomical patterns of these deformities of the hand confirms the most commonly held view of the mechanism of the production of congenital deformities. Environmental factors, of which there are many, inhibit the rate of development of the part which is most actively differentiating. The time at which they act is, therefore, more important than their nature, and the same factor will produce different effects at different times (Stockard, 1921). This process is modified at all stages by the genetic pattern of the individual (Zwilling, 1955).

INHERITANCE

Approximately 5 per cent. of hand deformities are inherited. Either the deformity is transmitted in pure form through many generations, or a tendency to deformity of the limb is transmitted, and the exact form varies, as in a family where the father had absence of one thumb, and his daughter bilateral radial club-hand. The families who transmit a severe deformity in pure form are not influenced by eugenic advice, when they know from personal experience that their offspring will be capable of leading a normal life.

ACKNOWLEDGMENTS

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FACTS AND FALLACIES

by
Jessie Dobson, B.A., M.Sc.
Curator of the Anatomical Museum

THE BEGINNING OF a realisation of the phenomena of natural history cannot be precisely defined : even the earliest writers on the subject, long before the Christian era, depended a great deal on the transmitted lore of unidentified observers in the even remoter past. Aristotle, writing in the third century B.C., notes that animals can be divided into two great classes, according to their mode of origin. The first are produced from other animals of the same kind, that is, forming an unbroken chain of parents and offspring. Two sexes were required because the male established the form and the female the substance of the succeeding generation, which might come into the world " alive " or in the form of eggs, grubs or larvae. On the other hand, some animals appeared apparently without benefit of parents, originating spontaneously by the natural union of various ingredients contained in decomposing mud or slime, vegetable tissues or from the earth itself. Clams, oysters, limpets—all the shellfish, without exception—were included in this class and such variations in form that were found were the result of the differing characters of the substance from which they arose.

Aristotle was one of the greatest scientific geniuses the world has ever known ; he was the Buffon, the Cuvier, the Owen, the Linnaeus of his time and it would be a mistake to regard these statements as being due to superstition or careless observation. This second group of creatures was assumed to be produced by spontaneous generation because no other method was visible—which was a perfectly reasonable assumption. The secrecy of animals about their reproductive habits ; the fact that birds, insects and fish in particular often lay their eggs far away from their normal habitat, with the result that the offspring only appear long after the parents have died or dispersed to other regions—the eggs of the American *Cicada septendecim* take anything up to seventeen years to hatch, as its name implies—all these things contributed to these early beliefs. Add to this the variety of metamorphoses to which many of the lower classes of living things are subject before arriving at their adult state and any criticism of these early biologists will change to admiration for the amount of accurate information that they were able to amass in the absence of modern aids to scientific research.

As a result of the pronouncements of Aristotle, Pliny, Galen and their followers, it was believed that the peak of learning had been reached and further investigations were unnecessary. This led to a smog of complacency settling over much of Europe, putting an effective brake on all progress in culture and civilisation, the influence of which was not removed for more than a thousand years. Knowledge of natural history and biology was transmitted from one generation to the next through the medium of the anecdotal type of " Animal Books," the first of which, written in the

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Greek language, appeared in about the second century A.D. under the reputed authorship of one, Physiologus. These books of beasts were translated into many languages and, though they contained much useful and accurate information, as time went on they also accumulated new legends and moral observations that successive generations considered exemplary and instructive for young scholars. In spite of their popularity, these books have been regarded as the lowest ebb of biological knowledge, especially as even the facts became distorted. In them we find the phoenix rising from the ashes of its own funeral pyre after nine days ; bees appearing in the rotting flesh of cows ; frogs and toads being produced from the mud of pools by the vivifying action of the sun's rays ; insects emerging from dew and rats from the river Nile.

The story of the pelican is entertaining. One version related that after being hatched, the young birds irritate the parents by flapping their wings and the parents kill them accidentally when they strike back with their more powerful pinions. After three days, the female parent, overcome with remorse, pierces her breast and pours out her blood over the little corpses, so bringing them back to life. But perhaps there may, after all, have been a basis of truth in this extraordinary story. In the *Proceedings of the Zoological Society* for the year 1869 (p. 146) is the record of an observation made by Mr. A. D. Bartlett, Superintendent of the Zoological Gardens at that time, to the effect that he had seen flamingoes eject a glutinous fluid, nearly resembling blood in colour, from their own mouths into those of other birds in the same enclosure. He obtained some of this fluid and found that it was indeed little else than blood. " Have we here," he says, " an explanation of the old story of the pelican feeding its young with its own blood ? I think we have ; for the flamingo was and still is, found plentifully in the country alluded to and it may be that in the translation the habit of the one bird has been transferred to the other."

At first only about fifty natural phenomena were related in these Bestiaries, but from time to time additions were made from other written works. The story of the barnacle goose, for example, only appeared after the publication of *Itinerarium Cambriae* by Gerald de Barry, or *Giraldus*, in 1187. Here are described birds called Barnacles which Nature produces in a wonderful manner, starting as gummy excrescences hanging by their beaks like seaweed attached to timber. When in the process of time they have gained their feathers, they either fall into the water or take their flight into the free air. " I have often seen with my own eyes," remarks the author, " more than a thousand minute embryos of birds of this species on the seashore hanging from one piece of timber." Almost five hundred years later, the story was still firmly believed. In 1678, Sir Robert Moray wrote an account in the *Philosophical Transactions of the Royal Society* of finding inside the shell the little bird curiously and completely formed— but never did he see any of the little birds alive nor met with anybody that did !

The strong superstitious belief in these legends as they appeared in these, to us, amusing but misleading books, was maintained in the face of most reliable scientific evidence to the contrary because of the moral teaching that was incorporated into the text and it took centuries to eradicate the fallacies and establish the facts. One of the most important events that caused doubts to be cast on the stories that they contained was the discovery of the New World. These new lands were provided not only with plant life but with animal and human populations also. This presented a serious problem—for why had it been necessary for Noah and his family to embark on an expedition with those surely somewhat uncongenial fellow-travellers, with the sole purpose of preserving living things from destruction so as to ensure the continuance of species if, in fact, they could have been created anew, or so it now seemed. The hitherto uncritical acceptance of the old beliefs was now being challenged.

José de Acosta, a Jesuit Father, sailed to Cartagena in 1571 and made many observations on the natural history of Peru. He found that this new flora and fauna differed markedly from that in the Old World. His religious beliefs demanded an explanation of this. He set forth his theories in his *Natural and Moral History of the Indies,* completed in 1599. In it, he suggested that after the subsidence of the waters of the flood, the animals gradually dispersed and those that found countries well suited to their mode of life survived and the rest perished. In the end, and after long periods of time, every region became populated by animals and plants best adapted to local conditions and not found elsewhere ; and this explains why every land shows such marked differences in structure and type among the living things which it supports.

But the battle for truth was not won without many a struggle. The possibility of the spontaneous generation of at least the lower animals persisted until well into the seventeenth century. William Harvey regarded insects as lumps of organic matter stamped with a definite form ; they could not be said to grow but were generated by chance and were not constant to their kinds. The caterpillar, he says, does not, like an honest creature, make more caterpillars ; it turns into a butterfly. Carrion flies were bred out of filth without previous ancestry. So in the insect world there were no real species but only a breed of endless pest and corruption that had no logical form and no discoverable scheme. In his *De Generatione* he mentions more than once that the earth produces " many things of its own accord without any seed."

Jan van Swammerdam, however, knew that this was not true. He was able to show in 1669 that the egg, the caterpillar, the pupa and the butterfly were all one and the same individual in different growing stages. He actually tried to do more than this, to demonstrate—to the astonishment of his scientific audience—all parts of the butterfly in the body of a caterpillar. This led to the theory of " embôitement " which was in many ways similar to Marcello Malpighi's idea of " preformation." Now these concepts were quite in accord with the religious beliefs of the time ; no

new creation was postulated in the production of the new animal. Each egg contained a complete individual and it only needed the appropriate stimulus to cause it to unfold and grow ; and that individual too contained a further complete embryo for the next generation. One ingenious writer went so far as to compute the number of potential men and women that Eve must have included within her ovary—a grand total of twenty-seven millions.

But now a further complication occurred. Anthony van Leewenhoek and his physician friend, Dr. Hamm, introduced to the scientific world in 1677 some more of his " little animals "—the spermatozoa. This discovery set up a rival school of thought : it was not the ovum but the spermatozoon which contained the preformed organism. Proofs of this theory were eagerly sought and as readily found. François de Plantade who, for reasons unrevealed, called himself " Dalenpatius," wrote a letter to the Editor of the *Nouvelles de la République des Lettres,* much of which was published in the issue dated May 1699. A month later, Leewenhoek sent a letter to the Secretary of the Royal Society of London which was published in the *Philosophical Transactions* of that body in August of the same year. This contained an English translation of Dalenpatius's original letter where it was stated that a perfectly formed human being—the homunculus—had been found in the spermatozoon and an illustration was included to support the assertion. Leewenhoek, his professional jealousy aroused, denied that this was possible : he had examined hundreds of spermatozoa with the most powerful magnifying glasses then known and had never seen such a creature. The argument continued and, as the late Professor Cole remarked, these preformation theories hung round the neck of the embryologist like a millstone for more than a century.

But the seventeenth century did resolve many of the problems in natural history that had remained unanswered since Aristotle's first pronouncements. That remarkable man, Sir Thomas Browne, showed the absurdity of many of these vulgar errors in his *Pseudodoxia Epidemica* published in 1646, though even he was not allowed thus lightly to destroy people's faith in the wisdom of the ancients. Among his many critics was Alexander Ross, one of King Charles I's chaplains, who advised Browne to go to Egypt and " there he will find the fields swarming with mice begot of the mud of Nylus, to the great calamity of the inhabitants."

Francesco Redi, however, proved in 1668, to everyone's satisfaction, that maggots are found in rotting meat not because of the putrefaction but as a result of eggs laid there by the blow-fly. But he was not able to solve the vexing question of how the grub got to the middle of the apple —indeed, he believed that the same agency which produced the flowers and the fruit might well produce the grubs and the flies also. It remained for his pupil, Valisnieri, to give the correct answer to this. It was Redi who suggested that eels do not originate from earthworms, as was then supposed, but breed in the sea, for he had observed elvers ascending the

rivers in spring. This was the first step towards the solution of what came to be known as the " Eel question." Aristotle had pointed out that these creatures appeared to possess no generative organs and assumed that, like so many other living things, they must be derived out of " the bowels of the earth " by some form of spontaneous generation—a view that even Izaac Walton favoured. Pliny decided that they must rub themselves against rocks and that the pieces scraped off their bodies came to life. Others believed that they originated from horse hairs that fell into the water and were miraculously endowed with a vital spark.

Lest it be thought that the solution of these biological problems was a matter of great simplicity, requiring no more than the application of time and thought, let it be realised that the explanation of the " Eel question " was not forthcoming for another two hundred years! It was not until 1896 that Professor Grassi of Rome communicated to the Royal Society of London through Ray Lankester the story of the reproduction and metamorphosis of the common eel. Lord Lister, the President of the Society, was in the Chair on the occasion of the partial elucidation of the intricacies in the life history of a creature known since the earliest times. Professor Grassi stated that after four years of intensive research he and his pupil, Dr. Calundruccio, had been able to solve the mystery that had occupied the attention of naturalists from the days of Aristotle. Grassi and Calundruccio did not entirely complete the work for it was not until ten years later that Johannes Schmidt published his findings to this effect in the *Rapports du Conseil International Exploratoires de la Mer.*

The seventeenth and eighteenth centuries saw the preliminary steps towards the solution of many problems the full explanation of which has only been forthcoming in our own lifetime. Leewenhoek, for example, observed the phenomena of reproduction by budding in the Hydra but failed to realise the significance of what he had seen. Abraham Trembley, in 1744, described this mode of generation for the first time in his monograph on freshwater polyps but, as in the case of the eel, the full story was not told for more than two centuries. It is now known that the hydra makes use of two methods of propagation, budding and egg production. These may alternate but, in general, the use of one or the other means seems to depend to a large extent upon environmental conditions. Similar duplication of methods of reproduction were described in the Salp in 1819 by von Chamisso, the poet and circumnavigator, and in the jellyfish by Michael Sars, the Norwegian zoologist.

The value of the " Animal Books " may perhaps be regarded as negligible for the serious-minded biologist of to-day ; but in the past they have provided the stepping stones by means of which much of our present knowledge has been gained.

THOMAS VICARY COMMEMORATION

THE COMMEMORATION WAS held this year on 29th October and commenced with the Thomas Vicary Lecture, which was delivered in the Edward Lumley Hall by Mr. H. R. Thompson, F.R.C.S., Master of the Worshipful Company of Barbers, who chose as the title of his lecture " Serjeant-Surgeons to The Majesties." This was the first occasion on which the Thomas Vicary Lecture was delivered by the Master of the Barbers' Company during his term of office. It is hoped that the lecture will be published in a future issue of the ANNALS.

Later in the evening the members of the Court of the Barbers' Company were entertained at dinner by the members of the Council of the College.

The President and Mr. Thompson processing from the Edward Lumley Hall af.er the Lecture.

DONATIONS

DURING THE LAST few weeks the following generous donations have been received :

Appeal Fund:

£250	The Worshipful Company of Fishmongers (First of seven annual gifts.)
£50	Broadstone Investment Trust.
£26 5s.	Killick Martin & Co. Ltd.
£25	Cooke & Stevenson, Ltd.
£21	Spink & Sons, Ltd.
£20	Miss M. V. Lester Garland.
£20	Mr. & Mrs. D. A. Crawford.
£10 10s.	Miss G. Dodds.
	Wilfred Burkinshaw, Ltd.
£10	Mr. & Mrs. R. Matheson.
£5	Moores (Sheffield), Ltd.
	Mrs. F. M. Arnold.
£2 2s.	J. H. Mudford & Sons, Ltd.
	Byran Botterill & Son, Ltd.
£1 1s.	Nichols & Co. (Sheffield), Ltd.

Appeal Covenant:

£25 p.a. for seven years   Marmite, Ltd.

Department of Dental Science:

£50   De Beers Consolidated Mines, Ltd. (further gift.)

Voluntary annual subscriptions and donations by Fellows:

The following Fellows of the College, Fellows in Dental Surgery, and Fellows in the Faculty of Anaesthetists have generously given donations or have undertaken to make an annual subscription under Covenant to the College :

Sir Russell Brain, Hon. F.R.C.S.	D. M. Nair, F.F.A.
J. E. Coolican, F.R.C.S.	K. L. Oldham, F.F.A.
C. J. M. Dawkins, F.F.A.	A. G. Parks, F.R.C.S.
J. R. Odell, F.F.A.	P. Paton Phillip, F.R.C.S.
C. A. Foster, F.F.A.	H. E. Pooler, F.F.A.
C. E. D. H. Goodhart, F.F.A.	W. B. Primrose, F.F.A.
H. E. Gordon, F.F.A.	A. S. Prophet, F.D.S.
S. M. Guerrier, F.F.A.	S. G. Ransom, F.F.A.
F. R. Gusterson, F.F.A.	G. A. Rawlins, F.F.A.
R. Jarman, F.F.A.	R. Bryce-Smith, F.F.A.
H. Howell-Jones, F.F.A.	L. F. Tinckler, F.R.C.S.

K. G. Lloyd Williams, F.F.A.

Mr. Myles L. Formby, F.R.C.S., The British Association of Urological Surgeons, and Messrs. John Wright & Sons, Ltd., have generously undertaken to provide tables for one of the new Committee Rooms and Mr. J. H. Mulvany, F.R.C.S., has kindly presented a chair for the Great Hall.

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THE PRINTING OF THE ANNALS

THE TIMES PUBLISHING Company, Limited, who have printed the ANNALS since its inception in 1947, have been obliged to discontinue printing because of alterations to their building. From January 1st 1960 the ANNALS will be printed by Messrs. Jackson, Ruston and Keeson of Pear Tree Court, E.C.1.

We wish to acknowledge our indebtedness to The Times Publishing Company, Limited for their efficiency and cooperation during the past twelve years.

APPOINTMENT OF FELLOWS AND MEMBERS TO CONSULTANT POSTS

M. J. JOSHI, F.R.C.S.   Honorary Assistant Surgeon to Sassoon Hospitals and Honorary Lecturer in Surgery at the B.J. Medical College, Poona, 1.

P. F. C. JACKSON, M.R.C.O.G.; F.R.C.S.   Consultant Obstetrician and Gynaecologist to St. Albans City Hospital and West Herts. and St. Paul's Hospitals, Hemel Hempstead.

The Editor is always glad to receive details of new appointments obtained by Fellows and Members, either through the Hospital Boards or direct.

DIARY FOR JANUARY

Fri.	1	Last day for nomination of candidates for election to the Board of Faculty of Anaesthetists.
Tues.	5	Final Membership Examination begins.
Tues.	12	Final F.D.S. Examination begins.
Thur.	14 2.00	Quarterly Council.
	5.00	SIR WALTER MERCER—Robert Jones Lecture—Recollections and reflections.*
Fri.	15 5.00	Board of Faculty of Dental Surgery.
Mon.	18	Basic Sciences Lectures and Demonstrations begin.
Tues.	19	Voting papers for election of Fellows to Board of Faculty of Anaesthetists issued.
		Final F.F.A. Examination begins.
Wed.	27	Primary F.R.C.S. Examination begins.
	5.00	DR. D. H. TOMPSETT—Arnott Demonstration—Preservation and injection in anatomical material.*
Thur.	28 5.00	LIEUT.-COL. J. C. WATTS—Hunterian Lecture—Missile injuries in Cyprus.*

* Not part of courses.

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